

unit 1

Thermal energy and change of matter

- **Lesson One: Thermal Changes Accompanying Physical Changes**
- **Lesson Two: Thermal initiation associated with chemical changes**
- **Lesson Three: Combustion, oxidation, and reduction**

1

Thermal Changes Accompanying Physical Changes

Thermal Changes :

Energy that enters or leaves matter when a change occurs in its physical state

This lecture discusses ✕

Thermal changes accompanying physical and chemical changes explaining the difference between endothermic and exothermic processes and reactions and their applications in daily life according to the law of conservation of energy

There are two main types:

A. Endothermic Processes

In these processes, matter absorbs heat from the surrounding medium (air, hand, or water).

EX

1. Sublimation of Iodine: Iodine transforms directly from solid to vapor (Solid to Gas).
2. Evaporation of Alcohol: When you put rubbing alcohol on your hand, it absorbs your body heat to evaporate, so you feel cold (Liquid to Gas).
3. Melting of Ice: Ice needs heat to turn into liquid (Solid to Liquid).

B. Exothermic Processes

In these processes, matter expels (releases) heat outward to the surrounding medium, raising the temperature of the surroundings

EX

1. Dissolving Detergent: When placing laundry powder in your hand with a little water, you feel heat. This is due to the release of thermal energy while the powder dissolves.
2. Freezing: Water turning into ice releases heat (Liquid to Solid).
3. Condensation: Water vapor turning into water releases heat (Gas to Liquid).

Phase changes and dissolution are reversible physical processes and do not involve breaking or forming new chemical bonds

Technological Application: The Refrigerator Cooling Cycle

Refrigerator Cooling Cycle

A closed, repetitive thermal process in which heat is withdrawn from inside the refrigerator and transferred to the surrounding medium (air) using a cooling liquid known as environmentally friendly "Freons."



How it works:

The cycle involves both endothermic and exothermic processes, where Freon passes through several stages:

1. Expansion and Evaporation:

- Liquid Freon passes under high pressure through a narrow valve.
- The liquid turns into a cold gas, absorbing heat from the food inside the fridge. (This is an Endothermic process).

3. Condensation:

- The hot gas passes through the pipe network behind the fridge.
- The gas cools and turns back into a liquid, accompanied by the release of heat to the surroundings. (This is an Exothermic process).

2. Compression:

- The compressor (fridge motor) sucks the gas and compresses it, raising the gas temperature.

Cooling food by continuously transferring heat from inside the refrigerator to the outside.

Thermal Changes in the Dissolution Process

Dissolving any substance (Solute) in another substance (Solvent) is accompanied by the loss or absorption of thermal energy to/from the surroundings.

Solute:

The substance being dissolved (e.g., table salt).

Solvent:

The substance doing the dissolving (e.g., water).

Surroundings:

Everything around the solution, such as the cup, the surrounding air, and the thermometer.

Heat of Solution :

The quantity of heat absorbed or released when a specific amount of solute dissolves in a known volume of solvent to form a solution.

Types of Dissolution (Exothermic vs. Endothermic)

Feature	Exothermic Dissolution	Endothermic Dissolution
Experiment	Adding 4g of solid Sodium Hydroxide (NaOH) to 100ml of water.	Adding 3g of solid Ammonium Nitrate (NH_4NO_3) to 100ml of water.
Observation	Initial Temp (T_1) = 25°C. Final Temp (T_2) = 35°C. ($T_2 > T_1$)	Initial Temp (T_1) = 25°C. Final Temp (T_2) = 19°C. ($T_2 < T_1$)

Explanation	When NaOH molecules dissociated, energy was released as heat. This heat transferred from the solution to the surroundings, raising the temperature.	To dissociate and dissolve, NH_4NO_3 molecules needed energy. They absorbed this energy (heat) from the surroundings, causing the surroundings to cool down.
Definition	A physical change accompanied by the release of thermal energy to the surroundings.	A physical change accompanied by the absorption of thermal energy from the surroundings.

Two nested polystyrene cups (like Styrofoam) were used as a thermal insulator to minimize heat loss/gain from external air, making the measurement more accurate.

Examples of Solubility in Water

Endothermic (Absorbs Heat)	Exothermic (Releases Heat)
Ammonium Nitrate $\text{NH}_4\text{NO}_3(\text{s})$	Sodium Hydroxide $\text{NaOH}(\text{s})$
Potassium Sulfate $\text{K}_2\text{SO}_4(\text{s})$	Calcium Chloride $\text{CaCl}_2(\text{s})$
Sodium Bicarbonate $\text{NaHCO}_3(\text{s})$	Sodium Carbonate $\text{Na}_2\text{CO}_3(\text{s})$
Hydrated Copper Sulfate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}(\text{s})$	Anhydrous Copper Sulfate $\text{CuSO}_4(\text{s})$
Hydrated Cobalt Chloride $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}(\text{s})$	Anhydrous Cobalt Chloride $\text{CoCl}_2(\text{s})$
Hydrated Lithium Chloride $\text{LiCl} \cdot \text{H}_2\text{O}(\text{s})$	Anhydrous Lithium Chloride $\text{LiCl}(\text{s})$

Hydrated vs. Anhydrous Substances

Hydrated Substance:

A chemical compound containing a fixed number of water molecules bound to it. Example: Hydrated Copper Sulfate (Blue).

Anhydrous Substance:

The same compound after removing water molecules, usually by heating. Example: Anhydrous Copper Sulfate (White).

Relationship (Inverse energy relationship):

- Heating (Endothermic): Heating the hydrated substance makes it absorb heat and turn into the anhydrous state.
- Adding Water (Exothermic): Adding water to the anhydrous substance makes it recombine with water, releasing heat.

Applications:

1. Copper Sulfate Transformation:

1. Anhydrous Copper Sulfate (CuSO_4): It is a white powder.
2. Adding drops of water (exothermic process): When water is added to it, it transforms into hydrated copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), which are blue crystals, and heat is released.
3. Heating (endothermic process): When the blue crystals are heated, they lose water, absorb heat, and return to the white powder.

2. Cobalt Chloride Transformation:

1. Hydrated Cobalt Chloride ($\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$): It has a pink color.
2. Heating (endothermic process): When heated, it absorbs heat and loses water to become anhydrous cobalt chloride (CoCl_2), which is blue.
3. Adding drops of water (exothermic process): When water is added to the blue form, it returns to the pink color, and heat is released.

Safety Rule: Diluting Acids

Q: When diluting concentrated acids, do you add acid to water or vice versa? Why?

A: You must add the concentrated acid gradually to the water, never the other way around.

Explanation:

1. Diluting concentrated acids is a highly exothermic process.
2. If you add water to acid: The amount of acid is large relative to the water initially. The massive heat released instantly causes the water to boil violently, splashing corrosive acid out of the container, causing severe burns.
3. If you add acid to water (Correct way): The large volume of water absorbs and distributes the released heat safely. Adding acid slowly allows heat to dissipate without violent boiling.

Relationship between Solute Mass and Temperature Change

Experiment:

- Dissolving different masses (1g, 2g, 3g, 4g) of Anhydrous Lithium Chloride (LiCl) in a fixed amount of water (30ml).

Data:

- Initial Temperature (T_i): Constant at 21°C in all cases.
- Adding 1 gram: The temperature rose to 25.5°C (Change in temperature $\Delta T = 4.5^\circ\text{C}$).
- Adding 2 grams: The temperature rose to 30°C (Change in temperature $\Delta T = 9^\circ\text{C}$).
- Adding 3 grams: The temperature rose to 34.5°C (Change in temperature $\Delta T = 13.5^\circ\text{C}$).
- Adding 4 grams: The temperature rose to 39°C (Change in temperature $\Delta T = 18^\circ\text{C}$).

Q Conclusion:

- The relationship is directly proportional. As the mass of the solute increases, the magnitude of the temperature rise increases proportionally. (For example, doubling the mass from 2 grams to 4 grams resulted in doubling the temperature rise from 9°C to 18°C).

Q Note:

- The dissolution of lithium chloride salt in water is an exothermic process, which is why the temperature of the solution rises. The amount of heat released is directly proportional to the mass of the dissolved salt. Therefore, the greater the mass of the salt, the greater the increase in temperature.

- Independent Variable (Cause)** : Mass of lithium chloride (solute).
- Dependent Variable (Result)** : The change in temperature (ΔT).
- Constant Variable** : Volume of water (solvent).

Life Application: Instant Cold and Hot Packs

Q Structure:

Single-use packs containing an outer flexible bag with two separate compartments:

- Solid chemical substance (Solute).
- A thin water bag that bursts when squeezed.

Mechanism

Squeezing breaks the water bag, mixing water with the chemical. Dissolution occurs immediately, causing the pack to cool down or heat up.



	Instant Cold Compress	Instant Hot Compress
Solute	Ammonium nitrate salt (NH_4NO_3).	Magnesium sulfate salt (MgSO_4).
Thermal Change	Endothermic dissolution: When ammonium nitrate dissolves in water, it absorbs heat from its surroundings (the water and your body), leading to a sharp drop in temperature and a feeling of intense cold.	Exothermic dissolution: When magnesium sulfate salt dissolves in water, it releases a significant amount of heat, causing the compress to heat up quickly.
Use	Used to reduce swelling and bruises. (Reason): The cold constricts blood vessels, which reduces blood flow to the affected area, thereby decreasing swelling.	Used to relieve pain associated with muscle strain and cramps. (Reason): The heat dilates blood vessels, which increases blood flow to the strained areas, relaxing contracted muscles and alleviating the sensation of pain.

Lesson (1) : Questions

First: Choose the correct answer

1. The transformation of Iodine from the solid state directly to the gaseous state is considered a process that is:

- A. Exothermic B. Endothermic C. Chemical D. Biological

2. The process of freezing is considered a process that is:

- A. Exothermic B. Endothermic C. Physical Endothermic D. Chemical Exothermic

3. In the refrigerator cooling cycle, heat is absorbed from the food in the stage of:

- A. Condensation B. Compression C. Expansion and Evaporation D. External Cooling

4. When Sodium Hydroxide dissolves in water, the temperature of the solution:

- A. Decreases B. Remains constant C. Increases D. Becomes zero

5. Dissolving Ammonium Nitrate in water is considered a dissolution that is:

- A. Exothermic B. Endothermic C. Very fast D. Non-spontaneous

6. In exothermic dissolution, the final temperature (T_2) is:

- A. Less than T_1 B. Equal to T_1 C. Equal to zero D. Greater than T_1

7. Which of the following substances has an endothermic dissolution in water?

- A. Potassium Sulfate B. Calcium Chloride C. Sodium Hydroxide D. Magnesium Sulfate

8. When heating hydrated Copper Sulfate, it turns into the color:

- A. Red B. White C. Black D. Blue

9. The transformation of Cobalt Chloride from blue to pink is considered a process that is:

- A. Endothermic B. Exothermic C. Neutralization D. Combustion

10. The relationship between the amount of solute and the change in temperature (ΔT) is a relationship that is:

- A. Inverse B. Direct C. Constant D. Decreasing

11. Hot packs work to:

- A. Constrict blood vessels B. Lower temperature C. Clot blood D. Dilate blood vessels

12. Cold packs are used in cases of:

- A. Bruises and swelling B. Muscle cramps C. Activating blood circulation D. Warming

13. The substance used in instant hot packs is:

- A. Magnesium Sulfate B. Sodium Chloride C. Ammonium Nitrate D. Calcium Carbonate

14. Polystyrene material is used in dissolution experiments because it is:

- A. A good heat conductor B. A thermal insulator
C. A solvent material D. A solute material

15. Cold packs work to:

- A. Reduce blood flow B. Increase blood flow C. Raise body temperature D. Dilate arteries

16. The cooling cycle in a refrigerator is considered a process that is:

- A. Open B. Closed C. Chemical D. Manual

Fill in the blanks

1. In the cooling cycle, the liquid turns into a cold gas inside the refrigerator in the stage of
2. The dissolving of in water is an example of exothermic dissolution.
3. In endothermic dissolution, the final temperature is than the initial temperature.
4. The color of Cobalt Chloride turns from to when water is added to it.
5. When diluting acids, must be added to
6. packs are used to lower temperature and treat swelling.
7. gas is the substance used to transfer heat in refrigerators.

Write the Scientific Term

1. Processes in which the substance expels heat to the surrounding medium.
2. The substance that is dissolved in another substance to form a solution.
3. The substance that performs the dissolving, like water.
4. The thermal change accompanying the process of dissolving a quantity of solute in a solvent.
5. A chemical compound containing water molecules bound to it in a fixed manner.
6. The process of a substance transforming from the gaseous state to the liquid state with the release of heat.
7. A device in the refrigerator that draws in gas and compresses it to raise its temperature.
8. An instant medical device using Ammonium Nitrate to generate cold.
9. A medical device using Magnesium Sulfate to generate heat.

10. The transformation of Iodine from solid to gas directly by absorbing heat.

Mark (✓) or (X) with correction

1. The process of ice melting is an exothermic process.
2. When alcohol evaporates from the hand, we feel cold.
3. Freons are environmentally friendly materials used in refrigeration.
4. Dissolving Sodium Hydroxide raises the water temperature.
5. The solvent is the substance present in a smaller quantity in the solution.
6. In endothermic dissolution, $T_2 > T_1$.
7. Anhydrous Copper Sulfate is blue in color.
8. Adding water directly to concentrated acid is a safe action.
9. The temperature of the solution increases with the increase of the solute mass in exothermic dissolution.
10. Hot packs are used to treat fresh bruises and swelling.
11. Ammonium Nitrate is used in hot packs.
12. The refrigeration cycle relies on repeated endothermic and exothermic processes.

Give reasons for...

1. We feel cold when putting alcohol on our hands?
.....
2. Is ice melting considered an endothermic process?
.....
3. The temperature of water rises when dissolving Sodium Hydroxide in it?
.....
4. It is preferred to use polystyrene cups in dissolution experiments?
.....
5. The color of blue Copper Sulfate turns white upon heating?
.....
6. Acid must be added to water gradually when diluting, not the other way around?
.....
7. Cold packs are used in cases of bruises?
.....
8. Hot packs are used in cases of muscle stress?

9. Repeating the cooling cycle in the refrigerator continuously?

.....

What happens when...?

1. Placing solid Iodine crystals in a warm atmosphere?

.....

2. Water vapor touching a cold surface?

.....

3. Dissolving Ammonium Nitrate in water?

.....

4. Heating pink hydrated Cobalt Chloride?

.....

5. Adding water quickly to concentrated Sulfuric Acid?

.....

6. Doubling the mass of Lithium Chloride dissolved in the same volume of water?

.....

7. Pressing on the instant cold pack?

.....

8. Using hot packs on an area with fresh swelling?

.....

Comparisons

1. Endothermic Dissolution vs. Exothermic Dissolution

.....

2. Instant Cold Packs vs. Instant Hot Packs

.....

Miscellaneous Questions

1. What are the safety precautions when dealing with concentrated acids?

.....

2. How can you practically distinguish between Ammonium Nitrate and Sodium Hydroxide using only water?

.....

3. Explain with an equation the transformation of Copper Sulfate from hydrated to anhydrous?

.....

4. What role does the compressor play in the refrigerator?

.....

5. Describe the structure of the instant pack from the inside?

.....

6. How does the quantity of solute affect the accuracy of results in the heat of solution experiment?

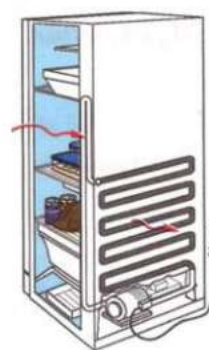
.....

7. Study the opposite figure then answer:

- a) What is the physical process occurring in the "Evaporator" part? And what is the type of thermal change accompanying it?
-

b) What role does the "Compressor" play in this cycle? And why does the gas temperature rise after passing through it?

.....



8. Study the opposite figure then answer:

- a) What is the chemical substance used in this type of pack? And what type of dissolution occurs when activating it?
-



b) What is the mechanism by which this pack works to reduce swelling and bruises?

.....

- c) Describe the structure of the pack from the inside and how it is activated to start working?
-

9. Write the chemical formula:

- a) Sodium Hydroxide
- b) Ammonium Nitrate
- c) Hydrated Copper Sulfate:
- d) Anhydrous Copper Sulfate:
- k) Anhydrous Cobalt Chloride:

2

Thermal initiation associated with chemical changes

Law of Conservation of Matter

"When a chemical reaction occurs, reactants are not destroyed, nor are new substances created from nothing; rather, the atoms of the reactant elements are rearranged to form new products."

Reaction of Carbon (C) with Oxygen (O₂).

- Reactants: 1 Carbon atom + 2 Oxygen atoms.
- Products: Carbon dioxide molecule (CO₂) consisting of the same atoms: 1 Carbon atom and 2 Oxygen atoms.
- The atoms did not disappear nor appear from nothing, but rather rearranged themselves.

Law of Conservation of Matter:

Energy is neither destroyed nor created from nothing, but it can be converted from one form to another.

This lecture discusses

Thermal changes accompanying chemical reactions by clarifying the laws of conservation of matter and energy, and explaining the difference between exothermic and endothermic reactions, the mechanism of their occurrence, and their practical applications in daily life

What applies to matter applies to energy.

Tools:

- Two lemons, a Copper rod (Cu), a Zinc rod (Zn), wires, LED lamp.

Steps:

1. Insert a copper rod and a zinc rod into each lemon.
2. Connect the zinc rod in the first lemon to the copper rod in the second lemon.
3. Connect the remaining two ends (the first copper rod and the second zinc rod) to the lamp.

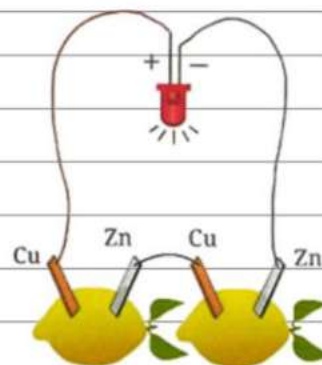
Explanation:

- A chemical reaction occurs inside the acidic lemon juice between the copper and zinc metals. This reaction produces an electric current that flows through the wires and causes the lamp to light up.

Conclusion:

The chemical energy stored in the lemon juice and the reactants is converted into electrical energy, which fulfills the Law of Conservation of Energy.

Activity (The Lemon Battery)



Observation:

- The lamp lights up.



Application of the Law to the Previous Experiment:

Energy was not "created" to light the lamp; it already existed in the form of chemical energy and was converted into another form (electrical).



Scientist Hermann von Helmholtz:

A German scientist who proved the Law of Conservation of Energy and demonstrated that the total energy in any isolated system remains constant.



The Relationship Between Chemical Reactions and the Law of Conservation of Energy

A chemical reaction is a two-step process:



1. Breaking Bonds (in Reactants)

- For the reaction to start, the bonds holding the atoms of the reactants together must first be broken.
- The process of breaking bonds is an endothermic process. Meaning, it requires and consumes energy from the surrounding medium to occur.



2. Forming New Bonds (in Products)

- After the atoms dissociate, they rearrange themselves and form new bonds to create the products.
- The process of forming bonds is an exothermic process. Meaning, it releases energy to the surrounding medium when it occurs.

Why is a reaction exothermic or endothermic?

- Mostly, the amount of energy absorbed (to break bonds) and released (to form bonds) are not equal; therefore, chemical reactions are accompanied by thermal changes that appear in the form of absorbed or released energy.



Types of Chemical Reactions According to Thermal Changes



First: Exothermic Reactions

Practical Activity - Reaction of Magnesium with Hydrochloric Acid



Materials and Tools

Dilute Hydrochloric Acid (HCl) / Magnesium Ribbon (Mg) / Two Polystyrene cups / Laboratory Thermometer / Glass rod.



Experiment Steps:

1. Place 50 ml of dilute hydrochloric acid in one of the polystyrene cups.
2. Record the initial temperature of the acid (T_1) using the thermometer. This is the system temperature before the reaction starts.
3. Immerse the magnesium ribbon in the acid, stirring gently using the glass rod to ensure a complete and homogeneous reaction.
4. After the reaction is complete or stabilizes, record the final temperature (T_2) of the reaction mixture.

Q Observation:

After adding magnesium to the acid, a rise in the temperature of the mixture is observed, where the final temperature (T_2) is greater than the initial temperature (T_1).

Q Conclusion:

This rise in temperature indicates that the reaction has released thermal energy to the surrounding medium. This type of reaction is described as an exothermic reaction.



Exothermic Reactions:

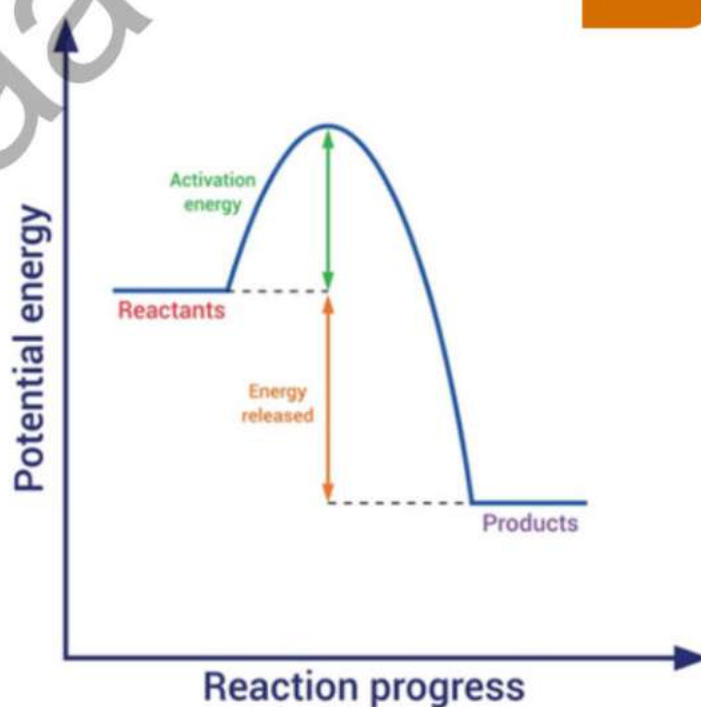
These are chemical reactions that result in the release of thermal energy as one of the reaction products into the surrounding medium, leading to an increase in the temperature of this medium.

Examples of Exothermic Reactions:

1. Reaction of metals with dilute acids: Such as the reaction performed in the practical activity (Magnesium with Hydrochloric Acid).
2. Reaction of alkalis with acids.
3. Reaction of metal carbonates with dilute acids.

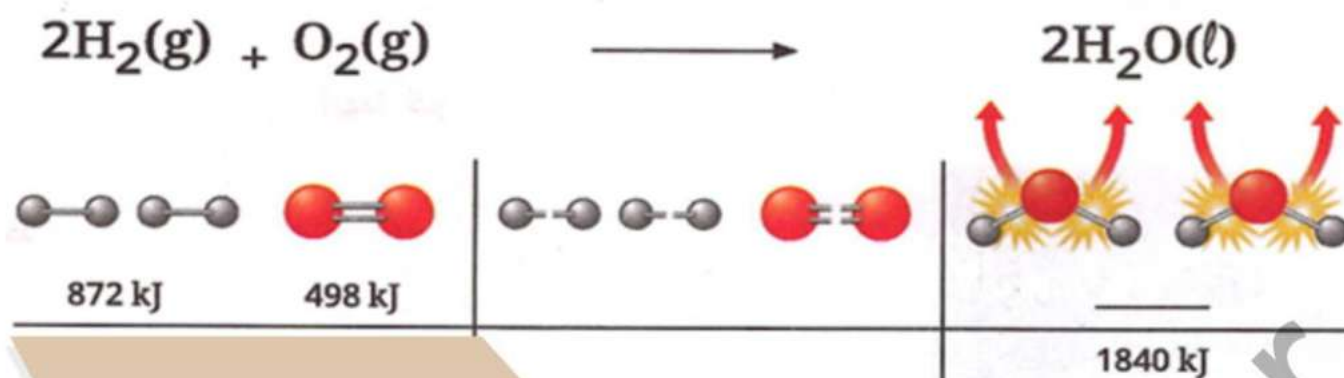
Energy Diagram for Exothermic Reactions:

- In exothermic reactions, the amount of energy released when forming new bonds in product molecules is greater than the amount of energy absorbed when breaking bonds in reactant molecules.
- This difference in energy appears in the form of released thermal energy, which corresponds with the Law of Conservation of Energy.



Application - Water Formation Reaction:

The reaction of hydrogen gas (H_2) with oxygen gas (O_2) to form water (H_2O) is an example of an exothermic reaction:



Energy Calculations:

- Energy Input (Energy absorbed to break bonds) : $872 + 498 = 1370$ kJ
- Energy Output (Energy released upon forming bonds) : 1840 kJ
- We notice that the sum of released energies (1840 kJ) is greater than the sum of absorbed energies (1370 kJ).
- This reaction releases an amount of energy equal to the difference between the released energy and absorbed energy: 470 kJ. This released energy appears in the form of thermal energy, confirming that the reaction is exothermic and complies with the Law of Conservation of Energy.

Integration with Life Sciences (Biology) - Fireflies

- Fireflies are an example of exothermic reactions in biological systems.
- These insects emit light from the abdominal region as a result of exothermic chemical reactions occurring inside their bodies. In these reactions, most of the resulting energy is converted into light (not heat).
- These insects control the timing and duration of the light they use for various purposes, such as mating or self-defense.



Real-Life Applications of Exothermic Reactions

1. Instant Self-Heating Cans:

These cans are used to heat drinks or food quickly without the need for an external heat source. They rely on the concept of an exothermic chemical reaction.



Structure:

- These cans contain an inner cone containing Calcium Oxide (CaO) (Quicklime) and water, separated from each other by a thin membrane.



Mechanism:

- When a button at the bottom of the cup is pressed, the thin membrane ruptures, allowing the calcium oxide and water to mix. An exothermic chemical reaction occurs between them, forming a Calcium Hydroxide solution (Limewater) with the release of a large amount of heat.





Importance:

- These cans are used to prepare coffee or heat food quickly using the heat released from the reaction without needing an external heat source.

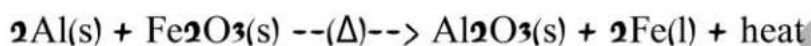
Important Note:

1. The common name for Calcium Hydroxide solution $\text{Ca(OH)}_2(\text{aq})$ is Limewater.
2. The common name for Calcium Hydroxide powder $\text{Ca(OH)}_2(\text{s})$ is Slaked Lime.

2. Thermite Reaction:

is a highly exothermic chemical reaction used in specific industrial applications.

- The reaction of Aluminum (Al) with Red Iron Oxide (Fe_2O_3) is accompanied by the release of a large amount of thermal energy. This intense heat leads to melting the iron produced from the reaction



- Where (Δ) indicates the need for heat to start the reaction, and "heat" indicates the released thermal energy.

This reaction is used mainly in welding railway tracks.

Second: Endothermic Reactions

Practical Activity

Materials and Tools

: Barium Hydroxide powder (Ba(OH)_2) / Ammonium Chloride powder (NH_4Cl) / Water / Glass beaker / Glass stirring rod / Wooden block / Digital thermometer.

Experiment Steps:

1. Wet the wooden block with a little water and place the glass beaker containing Barium Hydroxide powder on top of it.
2. Record the initial temperature of the powder (T_1) using the thermometer.
3. Add Ammonium Chloride powder to the beaker and stir the mixture well.
4. Record the final temperature (T_2) after the reaction ends.
5. Lift the beaker off the wooden block.

Observation and Explanation:

- Temperature Drop: It is observed that the final temperature (T_2) became much lower than the initial temperature (T_1), where the thermometer recorded a negative value (-0.03°C).
- Beaker sticking to the wood: The glass beaker stuck to the wet wooden block. This happened because the reaction absorbed heat from the surrounding medium (the water between the beaker and the wood), leading to the freezing of the water.

Q Conclusion:

The reaction of Barium Hydroxide with Ammonium Chloride is an endothermic reaction. This means it needs to absorb thermal energy from the surrounding medium to occur, leading to a decrease in the temperature of the system (reactants) and the surrounding medium.

Endothermic Reactions :

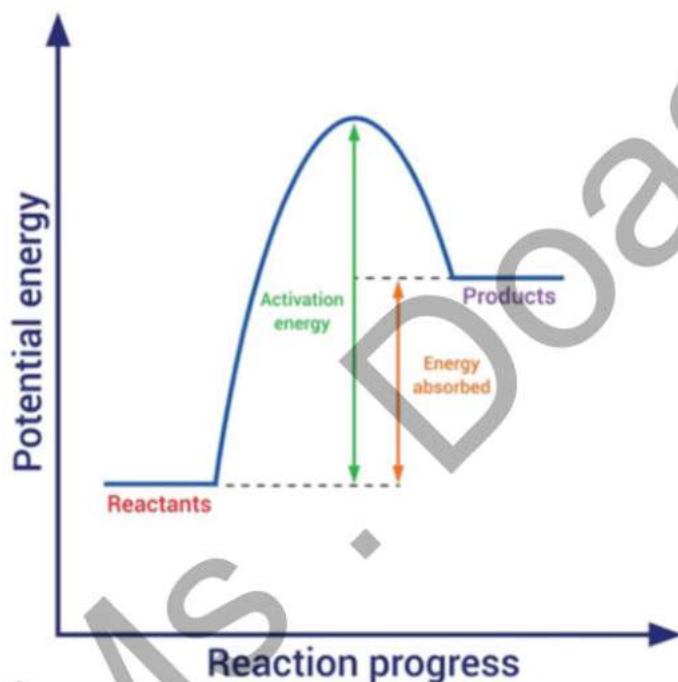
chemical reactions that require the absorption of thermal energy from the surrounding medium to occur, causing the temperature of the medium to drop.



Examples of Endothermic Reactions:

- Thermal Decomposition of Limestone (Calcium Carbonate CaCO_3): Needs heat to decompose.
- Decomposition of Ozone gas (O_3) in the atmosphere : Absorbs energy to decompose into oxygen.
- Reaction of Sodium Bicarbonate with dilute acids.

All thermal decomposition reactions are endothermic reactions.



- Reactants Energy : The energy of the reactants (present at the start of the reaction) is low.
- Products Energy: The energy of the products (present at the end of the reaction) is high.
- Absorbed Energy : For reactants to convert into products, the system must absorb energy from the surrounding medium. This energy is used to break the bonds in the reactant molecules.
- Released Energy : When new bonds are formed in the product molecules, energy is released.
- In endothermic reactions, the energy absorbed to break bonds is greater than the energy released when forming bonds.
- The difference between the two energies appears as thermal energy absorbed by the system from the surrounding medium, and this agrees with the Law of Conservation of Energy.

Comparison Between Exothermic and Endothermic Reactions

Aspect	Exothermic Reactions	Endothermic Reactions
Definition	Chemical reactions that result in the release of thermal energy. This energy transfers to the surrounding medium, causing its temperature to rise.	Chemical reactions that require the absorption of thermal energy from the surrounding medium to occur, leading to a decrease in the temperature of the medium.
Examples	- Reaction of metals with dilute acids. - Reaction of alkalis with acids. - Reaction of metal carbonates with dilute acids.	- Thermal decomposition reaction of Calcium Carbonate. - Decomposition reaction of Ozone gas in the atmosphere. - Reaction of Sodium Bicarbonate with dilute acids.
Energy Explanation	The amount of energy released when forming new bonds in product molecules is greater than the amount of energy absorbed required to break bonds in reactant molecules.	The amount of energy released when forming new bonds in product molecules is less than the amount of energy absorbed required to break bonds in reactant molecules.
Final Result	The reaction (system) releases thermal energy equal to the difference between the amounts of released and absorbed energy, fulfilling the Law of Conservation of Energy.	The reaction (system) absorbs thermal energy equal to the difference between the amounts of released and absorbed energy, fulfilling the Law of Conservation of Energy.

Lesson (2) : Questions

Multiple Choice Questions

1. Which of the following statements accurately describes what happens to energy during the breaking of chemical bonds?

- A. Thermal energy is released to the surroundings.
- B. Chemical energy is converted to light energy only.
- C. The system absorbs energy from the surroundings to overcome attractive forces.
- D. No change in energy occurs because matter is not destroyed.

2. In the lemon battery experiment, energy is converted into energy.

- | | |
|--------------------------|--------------------------|
| A. Electrical – Chemical | B. Chemical – Electrical |
| C. Thermal – Electrical | D. Light – Thermal |

3. If the energy required to break reactant bonds is (500 kJ) and the energy released when forming products is (300 kJ), then this reaction is:

- | | |
|---------------------------------------|--------------------------------------|
| A. Endothermic and net energy is +200 | B. Exothermic and net energy is -200 |
| C. Exothermic and net energy is +200 | D. In a state of thermal equilibrium |

4. The substance used in self-heating cans is:

- | | | | |
|---------------|----------------------|---------------------|------------------|
| A. Iron Oxide | B. Ammonium Chloride | C. Barium Hydroxide | D. Calcium Oxide |
|---------------|----------------------|---------------------|------------------|

5. Which of the following is considered an example of an endothermic reaction in nature?

- | | |
|-----------------|------------------------------------|
| A. Iron rusting | B. Decomposition of ozone gas |
| C. Forest fires | D. Respiration of living organisms |

6. The chemical name for "lime water" produced in self-heating cans is:

- | | | | |
|----------------------|------------------|----------------------|--------------------|
| A. Calcium Carbonate | B. Calcium Oxide | C. Calcium Hydroxide | D. Calcium Sulfate |
|----------------------|------------------|----------------------|--------------------|

7. The Thermite reaction is used in:

- | | |
|---------------------------|------------------------------|
| A. Welding railway tracks | B. Manufacturing fertilizers |
| C. Cooling beverages | D. Lighting streets |

8. Biological reactions inside bioluminescent insects are considered:

- | | | | |
|----------------|---------------|------------|---------------|
| A. Endothermic | B. Exothermic | C. Nuclear | D. Electrical |
|----------------|---------------|------------|---------------|

9. All of the following reactions are exothermic except:

- | | |
|--|-----------------------------|
| A. Reaction of alkalis with acids. | B. Thermite reaction. |
| C. Thermal decomposition of Calcium Carbonate. | D. Combustion of Magnesium. |

10. The thin membrane in self-heating cans separates:

- | | | | |
|---------------------|--------------------|-----------------|------------------------|
| A. Coffee and water | B. Acid and alkali | C. Fuel and air | D. Quicklime and water |
|---------------------|--------------------|-----------------|------------------------|

11. The chemical formula for slaked lime is:

- | | | | |
|--------|----------------------|------------------------|----------------------|
| A. CaO | B. CaCO ₃ | C. Ca(OH) ₂ | D. CaCl ₂ |
|--------|----------------------|------------------------|----------------------|

12. The reaction of sodium bicarbonate with dilute acids is considered one of the:

- | | |
|-------------------------|--------------------------|
| A. Exothermic reactions | B. Endothermic reactions |
| C. Nuclear reactions | D. Light reactions |

13. When a chemical reaction occurs in an isolated system, the total energy:

- | | | | |
|--------------|--------------|---------------------|-------------|
| A. Increases | B. Decreases | C. Remains constant | D. Vanishes |
|--------------|--------------|---------------------|-------------|

Complete the Sentences

1. A chemical reaction involves two processes that are opposite in energy: and
2. In exothermic reactions, heat transfers from to
3. When mixing calcium oxide with water in self-heating cans, the compound is formed and thermal energy is released.
4. The Thermite reaction is a strongly exothermic reaction that occurs between and
5. In the energy diagram for an endothermic reaction, the energy of reactants is than the energy of products.
6. All reactions are considered endothermic reactions.
7. In the lemon battery, the rod acts as the positive pole and the rod acts as the pole that dissolves.

Write the Scientific Term

1. Chemical reactions that require the absorption of thermal energy from the surroundings to occur.
2. Energy is neither created nor destroyed from nothing, but changes from one form to another.
3. A chemical reaction used in welding railway tracks that produces very high heat.

4. Cans used to heat beverages relying on the reaction of quicklime with water.
5. Chemical reactions that result in the release of thermal energy as one of the reaction products.
6. Living organisms that produce cold light as a result of exothermic chemical reactions inside their bodies.
7. The German scientist who proved the law of conservation of energy in isolated systems.
8. The substance produced from the reaction of aluminum with iron oxide, forming a solid layer.

Mark (✓) or (X) with correction

1. The process of breaking bonds is an exothermic process.
2. In exothermic reactions, the heat content (enthalpy) of the products is less than that of the reactants.
3. The Thermite reaction is used in cooling car engines.
4. When barium hydroxide reacts with ammonium chloride, the temperature of the beaker rises.
5. The sum of energies absorbed to break bonds in the water formation reaction is greater than the released energy.
6. The reaction of alkalis with acids is considered an exothermic reaction.
7. Bioluminescent insects convert chemical energy into intense heat that burns what is around them.
8. The decomposition of calcium carbonate is accompanied by heat absorption.
9. The energy of products in an endothermic reaction is very low compared to the reactants.

Give Reasons For

1. The reaction of magnesium with hydrochloric acid is considered an exothermic reaction.

.....

2. The decrease in the thermometer temperature when barium hydroxide reacts with ammonium chloride.

.....

3. The use of the Thermite reaction in welding railway tracks.

.....

4. Bioluminescent insects emit light from their abdomens.

5. Cans containing quicklime and water are called "self-heating".

6. The glass beaker sticks to the wet piece of wood in the barium hydroxide experiment.

7. Matter is not destroyed in a chemical reaction.

What Happens When?

1. Pressing the button at the bottom of the self-heating can.

2. Placing a magnesium ribbon in a beaker containing hydrochloric acid and recording the temperature.

3. Mixing barium hydroxide powder with ammonium chloride salt over a wet piece of wood.

4. Inserting a zinc rod and a copper rod into a lemon and connecting them to an LED bulb.

5. Lack of sufficient insulation for the cup in the reaction heat measurement experiment.

6. Removing the separating membrane in the self-heating can without the presence of water.

Miscellaneous Questions

1. Compare Exothermic Reaction and Endothermic Reaction.

2. Explain the working concept of the "Lemon Battery" and how it achieves the law of conservation of energy.

3. Using the following data for the water reaction: (Breaking Energy = 1370 kJ, Formation Energy = 1840 kJ), calculate the net energy and determine the type of reaction.

.....

4. What is the first step of any chemical reaction?

.....

5. How can chemistry explain a biological phenomenon like the light of fireflies (bioluminescent insects)?

.....

6. Write the balanced symbolic equation for the reaction of quicklime with water.

.....

.....

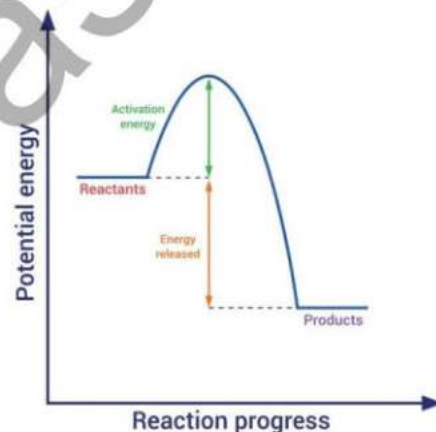
7. Study the opposite figure then answer:

A) Which is higher in energy: The reactants or the products?

B) What does the downward green arrow represent?

C) Write a reaction that represents this diagram.

.....



3

Combustion, Oxidation, and Reduction

Combustion

It is a rapid chemical reaction between a flammable substance (Fuel) and an oxidizing agent (usually Oxygen), resulting in the emission of energy in the form of heat and light.

- **Combustion is considered an exothermic reaction ?**
- Because it releases thermal energy into the surroundings.

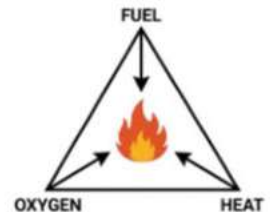
This lecture discusses

Combustion and does not react repulsively chemically, in addition to its obligations, types and types with its connection to nutrient content and reduction and its applications in daily life and technology

The Essential Elements of Combustion (The Fire Triangle)

For the combustion process to occur, three essential elements must be present. These are known as the Fire Triangle (Combustion Triangle):

1. Fuel: The flammable substance that oxidizes and releases energy.
2. Oxygen Gas: The oxidizing agent necessary for the reaction.
3. Heat: The energy required to start the reaction



Fuel

Flammable materials used to produce thermal energy as a result of an exothermic reaction.

Fuel comes in many forms, including:

1. **Fossil Fuels :** Such as coal, oil, and natural gas. Although it is a non-renewable resource, it is the most widely used in the world to date.

If any side of this triangle is removed, the combustion process stops.

The two primary fuels used in homes are:

Natural Gas:

Composed mainly of Methane gas (93%) in addition to some other hydrocarbons like Propane and Butane.

Butagas (LPG):

Composed of a mixture of Propane and Butane after separating them from natural gas.

Safety Awareness:

A very small percentage of Ethanethiol gas (which has a garlic scent) is added to both Natural Gas and Butagas both of which are odorless(to allow for appropriate safety measures in case of gas leaks.

2. Biofuel :

Such as Ethyl Alcohol (Ethanol), which is prepared from starch-rich plants like corn. Therefore, it is considered a renewable resource and is mixed with gasoline in some countries to be used as car fuel.

HYDROGEN CAR



3. Synthetic Fuel :

Such as Hydrogen gas, which is described as the fuel of the future and is used as fuel for cars and trucks powered by fuel cells (Hydrogen Fuel Cells).

This value is a measure of fuel efficiency.

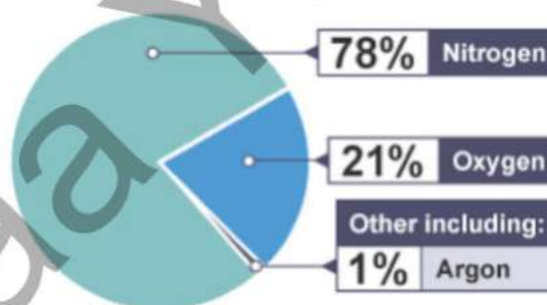
- This is the amount of energy (in Kilojoules kJ) produced by the complete combustion of 1 gram of fuel in an abundance of oxygen gas.

Fuel	Calorific Value (kJ/g)
Wood	20
Ethanol	30

Oxygen Gas

Oxygen is the decisive element in the combustion process, and the speed and efficiency of combustion depend directly on its concentration.

Composition of Atmospheric Air:



Effect of Oxygen Concentration on Combustion Speed:

Q: Does a piece of steel wool burn faster in air (21% oxygen) or in an atmosphere of pure oxygen (100% oxygen)?

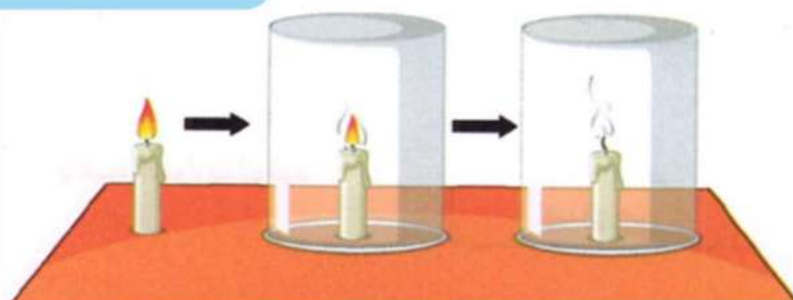
A: The steel wool burns much faster in an atmosphere of pure oxygen.

Explanation:

Increasing the oxygen concentration increases the number of oxygen molecules available to react with the fuel, which increases the rate of the chemical reaction (combustion), making it faster and more intense.

Practical Activity:

- When a burning candle is placed under a glass bell jar, it extinguishes after a short period.



Explanation:

- The main reason the candle extinguishes is the depletion of oxygen gas inside the glass jar. The candle continues to burn as long as oxygen is available. When the oxygen inside the jar is consumed, the fire triangle is disrupted (the oxygen side is removed), leading to the cessation of the combustion process and the extinguishing of the candle.

Types of Combustion (Complete and Incomplete)

- The Bunsen burner is used in laboratories as a practical example to study different types of combustion based on oxygen abundance.



Comparison	Complete Combustion	Incomplete Combustion
Definition	Combustion occurs when oxygen is available in sufficient quantity for all fuel molecules to combine with it.	Combustion occurs when the amount of oxygen is limited. The fuel cannot burn completely.
Oxygen Availability	High abundance of oxygen (Air vent open).	Limited quantity of oxygen (Air vent closed/restricted).
Flame Color	Blue	Yellow or Orange
Thermal Efficiency	Very high (produces a large amount of heat).	Low (produces less heat).

Heat

Heat is the third and final side of the fire triangle; it is the energy required to initiate the combustion reaction.

Ignition Temperature: The lowest temperature the fuel must reach to start burning.

Importance : The lower the ignition temperature of the fuel, the higher its flammability, which determines the danger level of its use and storage.

Practical Example :

Spark plugs are used in car engines to provide the necessary spark to ignite the mixture of gasoline and air in the combustion chamber to start the engine.





Technological Application: Oxy-acetylene Flame

- Used for cutting and welding metals (such as steel and copper).
- This flame is produced by the complete combustion of acetylene gas in an abundance of pure oxygen gas.
- The temperature of the resulting flame reaches about 3000 C which is sufficient to melt metals.



Chemical Reaction of Combustion (Example: Methane)

The combustion of hydrocarbons (like Methane CH_4 , the primary component of natural gas) in air leads to the formation of carbon dioxide gas and water vapor through an exothermic reaction



Spontaneous Combustion:

A phenomenon where a flammable material ignites without an external heat source (such as a flame, electrical spark, or friction).



- Cause:** • It occurs as a result of a spontaneous exothermic chemical reaction, where the heat generated by this reaction accumulates until the material's temperature reaches its ignition temperature.



- Lab Example:** • When drops of glycerin are added to potassium permanganate powder, a spontaneous exothermic reaction occurs, leading to self-ignition with the release of purple smoke.



- Lab Example:** • Spontaneous combustion can occur in piles of wet straw or hay due to the activity of decomposition bacteria, which gradually raises the temperature of the material until it reaches the ignition point.



Fire Extinguishing (The Extinguishing Triangle) X

- Fire extinguishing relies on the principle of removing one of the sides of the fire triangle.
- This principle is known as the Extinguishing Triangle.

The Basic Principles of Fire Extinguishing are:



1. Isolating Oxygen (Smothering)

- This is done by preventing oxygen from reaching the burning material.
- Methods : Using fire extinguishers containing foam, dry powder, or carbon dioxide gas (CO_2) which isolates the fire from the air. Sand is also used to extinguish fires of certain metals like sodium and magnesium.





Safety Precaution :

It is strictly forbidden to use water to extinguish sodium or potassium metal fires because these metals react with water in an exothermic reaction accompanied by the ignition of the rising hydrogen gas, which increases the intensity of the fire.



2. Cooling (Reducing Heat)

- This is done by reducing the temperature of the burning material to below its ignition temperature.
- Methods : Using water due to its high specific heat, making it effective in absorbing heat and cooling solid materials like paper and wood.



Safety Precaution :

It is forbidden to use water to extinguish oil fires because oil floats on the surface of the water (due to its density being lower than water), which leads to the fire spreading instead of being extinguished.



3. Removing Fuel

- This is done by removing the flammable material from the fire area, such as closing gas valves when fires occur.

Oxidation and Reduction

- Combustion reactions are described as oxidation-reduction (Redox) reactions.
- Oxidation and reduction are concurrent chemical processes that happen at the same time.

1. Oxidation Process:

- A chemical process that leads to an increase in the percentage of oxygen in a substance or a decrease in the percentage of hydrogen in it.

Example : Oxidation of Copper :

- When a stream of air is passed over heated copper powder (Cu) (heated to redness), the copper combines with atmospheric oxygen to form the black compound Copper Oxide (CuO).



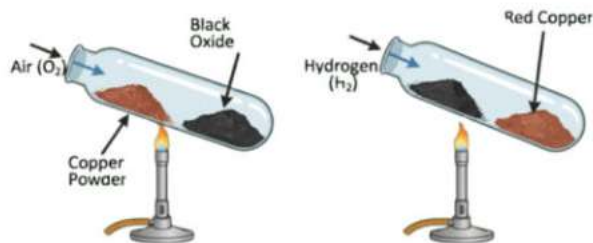
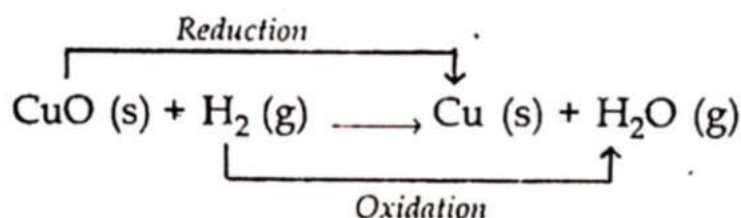
- In this reaction, oxidation of copper occurred because it gained oxygen. Copper in this case is known as the Reducing Agent.

2. Reduction Process:

- A chemical process that leads to a decrease in the percentage of oxygen in a substance or an increase in the percentage of hydrogen in it.

Example: Reduction of Copper Oxide :

- When a stream of hydrogen gas is passed over black copper oxide (CuO) with heating, reddish-brown copper and water vapor are formed.



In this reaction:

- Copper Oxide: Underwent reduction because it lost oxygen. It is known as the Oxidizing Agent.
- Hydrogen Gas: Underwent oxidation because it gained oxygen. It is known as the Reducing Agent.

Oxidizing Agent:

The substance that gives oxygen or takes hydrogen during a chemical reaction (it undergoes the reduction process)

Reducing Agent:

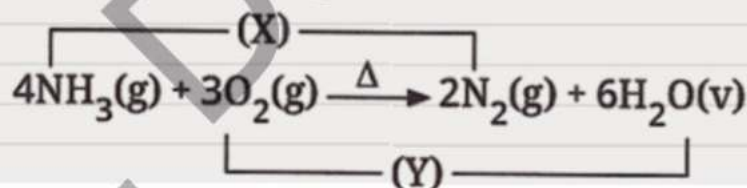
The substance that takes oxygen or gives hydrogen during a chemical reaction (it undergoes the oxidation process)

Technological Application: Food Preservation by Vacuum Packing

- Principle : Removing air provides a low-oxygen environment, which works to reduce oxidation and reduction reactions that lead to food spoilage.
- Result : Extending the shelf life of preserved foods.

"Training: "Assess Your Understanding

- **Ammonia gas burns incompletely in air according to the equation (implied):**



Clarify each of the following : ☒

- The Process (X) occurring to Nitrogen (N): ☒
- The Process (Y) occurring to Oxygen (O): ☒
- The Oxidizing Agent: ☒
- The Reducing Agent: ☒

Lesson Three: Questions

First: Multiple Choice Questions

1. Which of the following is considered the decisive factor in determining the speed and efficiency of the combustion process?
A. Type of fuel B. Temperature C. Concentration of oxygen gas D. Atmospheric pressure
2. The percentage of methane gas in natural gas is about and is considered its main component.
A. 78 % B. 93 % C. 21% D. 50%
3. The gas added to natural gas and LPG (Butagas) to distinguish its smell when leaking is:
A. Propane B. Methane C. Hydrogen D. Ethanethiol
4. The substance that oxidizes and releases energy in the fire triangle is known as:
A. Fuel B. Oxidizing agent C. Heat source D. Combustion products
5. Which of the following fuel types is classified as a renewable biofuel?
A. Coal B. Natural Gas C. Ethanol D. Gasoline
6. When using a Bunsen burner flame with a closed air hole (limited amount of oxygen), the flame color is:
A. Pale blue B. Yellow C. Transparent D. Violet
7. In the reaction of copper with oxygen: $2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}$, copper is considered:
A. A reducing agent B. An oxidizing agent C. A reaction medium D. A catalyst
8. The oxidizing agent is the substance that during a chemical reaction.
A. Donates hydrogen B. Removes oxygen C. Donates oxygen D. Donates nitrogen
9. The fuel described as the "fuel of the future" and used in fuel cells is:
A. Ethanol B. Natural Gas C. Coal D. Hydrogen
10. A candle stops burning inside a closed glass bell jar due to:
A. Rise in jar temperature B. Depletion of oxygen gas
C. Accumulation of nitrogen gas D. Complete melting of the candle
11. "Butagas fuel" (LPG) consists of a gaseous mixture of:
A. Propane and Butane B. Methane and Ethane
C. Hydrogen and Oxygen D. Ethanol and Methanol

12. Food is preserved by vacuum packing (removing air) to reduce reactions that cause spoilage.

- A. Hydrolysis B. Oxidation and Reduction C. Polymerization D. Neutralization

13. The blue flame in a Bunsen burner indicates:

- A. Lack of oxygen B. Incomplete combustion
C. Abundance of oxygen and complete combustion D. Decrease in temperature

14. The substance that removes hydrogen during a chemical reaction is considered:

- A. An oxidizing agent B. A reducing agent C. Fuel D. An inert substance

15. Which of the following is not considered a component of the "Fire Triangle"?

- A. Fuel B. Heat C. Carbon Dioxide D. Oxygen

16. "Closing gas valves" is considered an application of the principle of in fire fighting.

- A. Cooling B. Isolation C. Reducing pressure D. Removing fuel

17. is mixed with gasoline in some countries for use as car fuel.

- A. Methanol B. Ethanol C. Propane D. Hydrogen

Complete the Sentences

- The two main fuels used in homes are and
- The fire triangle consists of three elements:,, and
- Complete combustion occurs in an abundance of oxygen and produces a flame of color, while incomplete combustion produces a flame of color
- are used in car engines to provide the spark needed to start combustion.
- The oxidation process is a chemical process that leads to an increase in the percentage of or a decrease in the percentage of in the substance.
- The reducing agent is the substance that removes or donates during the reaction.
- When methane burns in the presence of oxygen, gas and are produced.
- Biofuel like is prepared from starch-rich plants like corn.
- The concept of extinguishing fire by "cooling" relies on lowering the heat of the burning material below the

Write the Scientific Term

1. A rapid chemical reaction between a flammable substance and an oxidizing agent resulting in light and heat.
2. A substance added to natural gas and LPG having a garlic smell to detect leaks.
3. The minimum temperature that fuel must reach to start burning.
4. A gas used as fuel for the future and has the highest calorific value (143 kJ/g).
5. A flame resulting from the combustion of acetylene gas in an abundance of oxygen, reaching a temperature of 3000°C.
6. The phenomenon of a substance igniting without an external heat source due to the accumulation of heat from internal reactions.
7. A chemical process that leads to a decrease in the percentage of oxygen in a substance or an increase in the percentage of hydrogen.
8. The substance that grants oxygen or removes hydrogen during a chemical reaction.
9. The amount of energy (in kilojoules) resulting from the complete combustion of 1 gram of fuel.
10. An extinguishing method that relies on preventing oxygen from reaching the burning material.
11. The substance that undergoes oxidation in an oxidation-reduction reaction.
12. A type of combustion that occurs when the amount of oxygen is limited and produces a yellow flame.
13. A gas that constitutes 78% of the components of the atmosphere.

Fourth: Mark (✓) or (X) with correction

1. Combustion is an endothermic chemical reaction.
2. Natural gas contains 93% butane gas.
3. Water is used to extinguish sodium and potassium fires.
4. The calorific value of hydrogen is higher than the calorific value of natural gas.
5. Complete combustion occurs when the amount of oxygen is limited.
6. The oxyacetylene flame is used in cutting and welding metals.
7. Spontaneous combustion can occur in piles of wet straw due to bacterial activity.
8. Oxidation and reduction are separate processes that do not occur at the same time.
9. The speed of combustion increases with the increase in oxygen gas concentration.

10. Carbon dioxide gas is used in fire extinguishers because it isolates the fire from the air.
11. Ethyl alcohol is considered a type of fossil fuel.

Give Reasons For

1. Ethanethiol substance is added to natural gas and LPG.

.....

2. A piece of steel wool burns in a cylinder filled with oxygen faster than it burns in atmospheric air.

.....

3. An extinguished candle goes out shortly after inverting a glass bell jar over it.

.....

4. The use of water is forbidden in extinguishing petroleum fires.

.....

5. Occurrence of spontaneous combustion in piles of straw or wet firewood.

.....

6. Oxyacetylene flame is used in cutting and welding metals.

.....

7. It is forbidden to extinguish sodium fires with water.

.....

8. It is preferred to use food preserved by vacuum packing technology.

What Happens When?

.....

1. Removing one of the sides of the fire triangle (Fuel, Oxygen, or Heat).

.....

2. Adding drops of glycerin to potassium permanganate powder.

.....

3. Passing a stream of air over copper powder heated to redness.

.....

4. Opening the air hole in a Bunsen burner to provide an abundant amount of oxygen.

5. Using water to extinguish a fire resulting from an electrical short circuit in the presence of sodium.

6. Passing hydrogen gas over hot black copper oxide.

7. Closing gas valves when a fire breaks out in the house.

Comparisons

1. Compare between Complete Combustion and Incomplete Combustion.

2. Compare between Oxidation Process and Reduction Process.

Essay Question

1. Explain with a balanced symbolic chemical equation the combustion reaction of methane gas.

2. How do "spark plugs" work in a car and what is their importance?

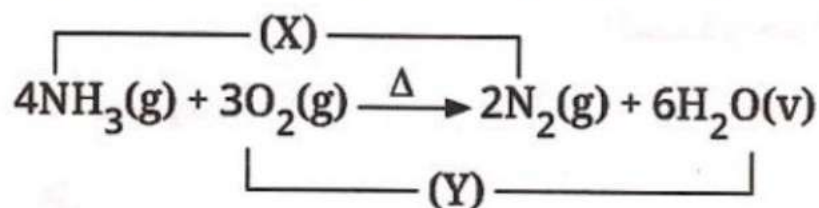
3. What is the "Fire Extinction Triangle"? Briefly mention its three methods.

4. Explain with a symbolic equation the effect of heat on copper in the presence of air, indicating the type of reaction.

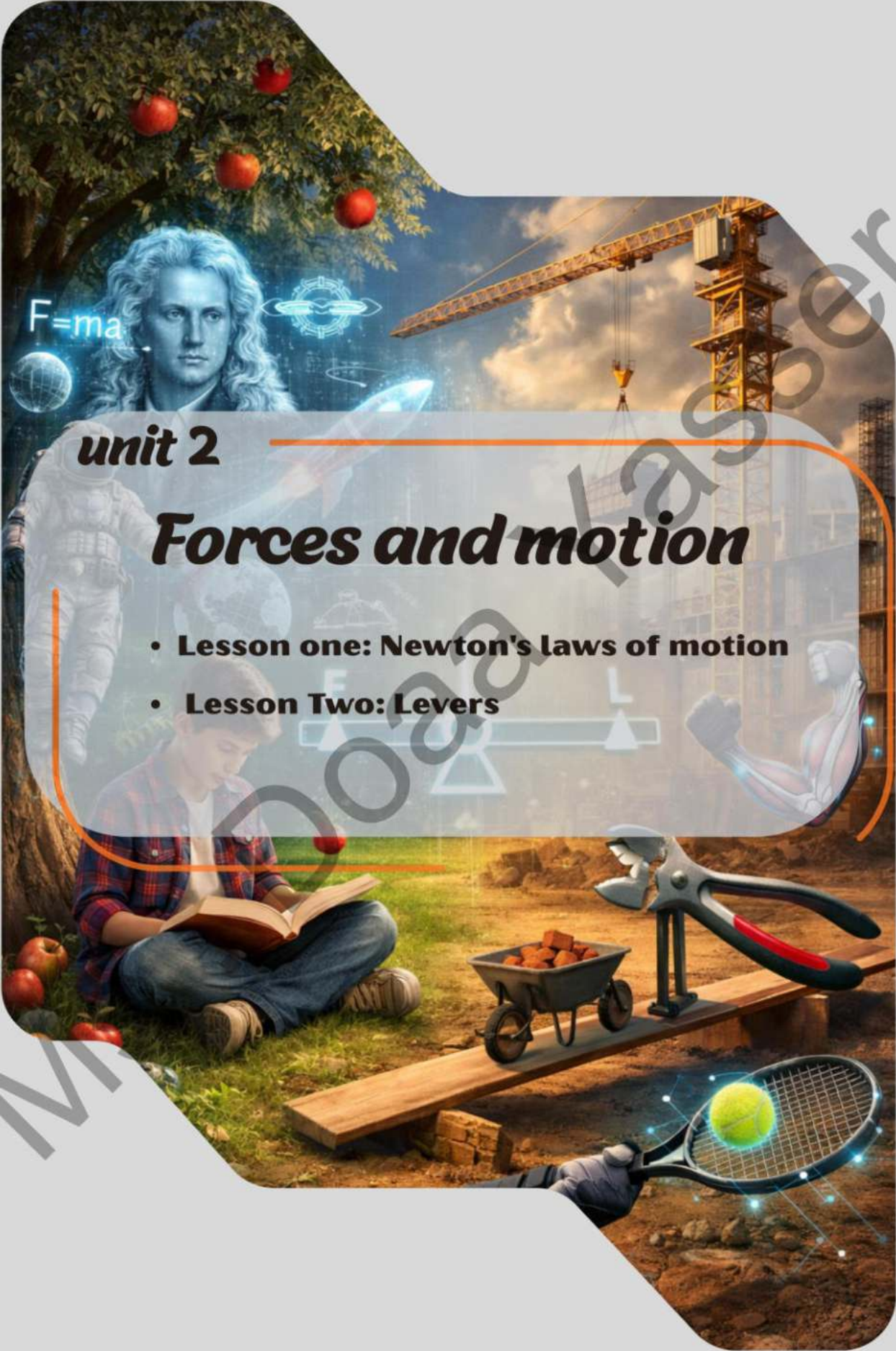
5. How does oxygen concentration affect the rate of the combustion reaction?

6. What are the gases composing the LPG cylinder? And how are they separated?

7. In the opposite reaction (referring to Ammonia reaction), clarify each of the following:



- Process (X) occurring to Nitrogen (N):
- Process (Y) occurring to Oxygen (O):
- The Oxidizing Agent:
- The Reducing Agent:



$F=ma$

unit 2

Forces and motion

- **Lesson one: Newton's laws of motion**
- **Lesson Two: Levers**

1

Newton's Laws of Motion

The Historical Debate on the Relationship between Force and Motion

Discuss this lecture ✕

The relationship between force and motion through the development of concepts from Aristotle to Galileo, and an explanation of Newton's three laws and their applications in explaining inertia, acceleration, and collisions, and their impact on daily life and modern technology.



The Ancient Belief

(Aristotle):

- It was believed that bodies by their nature tend towards rest, and that for bodies to remain moving, there must be a force acting upon them continuously.



The Correction

(Galileo):

- The scientist Galileo came and proved the error of Aristotle with a practical experiment. He concluded that moving bodies tend to retain their kinematic state unless an external force acts upon them (like friction) to stop them.
- This property was named "Inertia" (meaning that the body is incapable of changing its state by itself).



The ball maintains its motion unless acted upon by an external force.

Newton's Laws of Motion

- Newton's laws are considered the basis for studying the science of kinetics (movement).
- These laws are expressed in simple mathematical formulas used to study the causes of motion.



Brief about the Scientist Isaac Newton



His Identity:

An English scientist, one of the most prominent scientists of physics and mathematics in history, and one of the icons of the Scientific Revolution.



His Most Important Achievements:

- **Optics:** He presented huge contributions in the field of optics.
- **Mechanics:** He formulated the three laws of motion and the law of universal gravitation. (His theories remained dominant for 3 centuries until the appearance of the Theory of Relativity by Einstein).

- **Colors:** He established a theory about colors using the "prism" to analyze white light into the colors of the visible spectrum.
- **Other Discoveries:** He formulated a law for cooling, and studied the speed of sound in air.

Concept of Force and the Resultant (Net) Force

Force :

It is a vector physical quantity (meaning to define it, knowledge of its magnitude and direction is required) and it is measured in the unit of Newton (N).

Measurement Tool : It is measured by a device called the spring scale or the Newton meter.

- The Resultant Force : When a group of forces acts upon a body, the total force resulting from them in magnitude and direction is known as the resultant force, and it is what determines whether the body will move or stop or its speed or direction will change.
- The forces acting on the body may be balanced or unbalanced.



1. Balanced Forces:

- Occur when two forces equal in magnitude but opposite in direction act on the body along one line of action. In this case, each force cancels the effect of the other, and the resultant force acting on the body is the result of the difference between them (zero). Therefore, such forces are known as balanced forces.



Balanced Forces. Net Force = 0. Object remains at rest.

- **The Result:** The body remains in its kinematic state without change (if it was static it remains static, and if it was moving at a constant speed it continues at the same speed and direction).

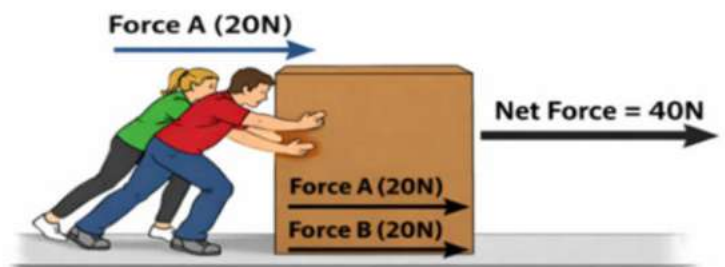


2. Unbalanced Forces:

- Occur when the resultant force acting on the body does not equal zero. This leads to a change in the body's motion (change in speed or direction).

It has two cases:

1. Two forces in the same direction: When two forces act in the same direction, the resultant equals the sum of the two forces, and the body moves in the same direction as the two forces.



Unbalanced Forces (Addition).
Net Force = 40N. Object accelerates.

2. Two forces opposite and unequal: When two different forces in magnitude and in two opposite directions act. The resultant = the difference between the two forces, and the body moves in the direction of the larger force.



Quick Summary:

1. **Balanced Forces:** Two forces equal in magnitude and opposite in direction = Resultant is zero.
2. **Unbalanced Forces (Addition Case):** Two forces in the same direction = Resultant is their sum (and same direction).
3. **Unbalanced Forces (Subtraction Case):** Two forces in opposite direction and unequal = Resultant is the difference between them (in the direction of the larger force).

Newton's First Law

Q: What is the reason for the static state of the bag placed on the table?

Answer: Because the forces acting upon it are balanced (the force of gravity downwards equals the force of reaction of the table upwards), and their resultant is zero. The static body tends to remain static.

Q: What is the condition necessary for the bag to move?

Answer: The existence of an unbalanced force acting upon it (like pushing it with a hand).

Q: Does the box placed on the roof of the car move at the same speed as the car, or is it static relative to an "observer" person standing on the sidewalk?

Answer: The box moves at the same speed as the car relative to the person standing on the sidewalk. (It is part of the moving car "system").

Q: What happens to the box upon the sudden stopping of the car?

Answer: The box rushes forward and falls. (Because it tried to retain its kinematic state).

Q: What do you conclude?

Conclusion: That bodies resist sudden change in their motion.



Object in motion stays in motion!



It becomes clear from the above:

1. When the forces acting on a body are balanced (their resultant is zero), the static body remains static and the moving body remains moving at the same constant speed and in a straight line.
2. Upon the sudden stopping of the car, the box rushes forward due to inertia, which is the tendency of the body to maintain its kinematic state.

Newton's First Law (Law of Inertia) :

A body remains in its state of rest or motion at a uniform speed in a straight line, unless an external unbalanced force affects it to change its state.

Example on Inertia:

- When the bus stops suddenly, the passengers rush to the front: The bodies of the passengers were moving with the bus, and when the bus stopped (due to the brakes), their bodies tried to continue the movement to the front.



The Relationship between the Inertia of the Body and Mass

The Basic Rule : "The greater the mass of the body, the greater its inertia."

This means that heavy bodies resist the change in their motion significantly more than light bodies.

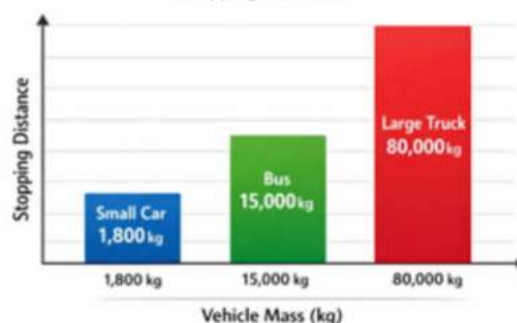
Activity (2): Analyze and Conclude:

- Comparison between three vehicles of different mass moving at the same speed: Small car (mass 1800 kg) - Bus (mass 15000 kg) - Large truck (mass 80000 kg).

Observations:

- When pressing the brakes with the same force, we find that the large truck takes a much longer distance to stop completely compared to the small car.
- Arrangement ascendingly according to stopping distance and time: (Car < Bus < Truck)

Relationship between Mass and Inertia
(Stopping Distance)



Scientific Conclusion:

- **Increase of stopping time and distance: Due to this high inertia, large trucks need a longer time and a larger distance to stop, and this is the reason why truck accidents are more dangerous.**

Q: What happens when cutting the electric current from the fan? With explanation.

Answer: The blades of the fan continue rotating for a short period before they stop completely.

Explanation: Due to inertia; where the fan blades try to retain their kinematic state and resist the sudden stop.

Q: What happens when pulling a tablecloth quickly from under a fruit dish? With explanation.

Answer: The fruit dish remains in its place on the table and does not move with the tablecloth.

Explanation: Due to inertia; for the dish was static and tries to retain the state of static and resist the sudden movement that the tablecloth was exposed to.



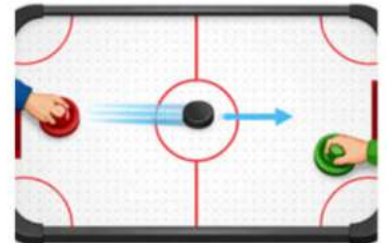
Technological Applications:

First : Cruise Control

- It is a device in modern cars that maintains the stability of speed without direct intervention from the driver.
- How it works? The device senses any change in speed and adjusts the fuel pumping to make the forces acting on the car balanced, which maintains the state of uniform motion (application of Newton's first law).

Second : Air Hockey

- An enjoyable game in which two circular rackets are used to push a light disk that slides on a smooth table that has holes through which a continuous current of air rushes. The
- Scientific Benefit: This air lifts the playing disk slightly from the table, which reduces friction between the disk and the table.
- The Result: It retains its kinematic state for a long period (application of the property of inertia).



Newton's Second Law

- Newton's first law states that the resultant force (sum of forces) is what causes the change of the body's state, whether it was in a state of rest or motion.
- Newton's second law explains how this force affects the change of the body's speed with the passing of time.

Newton's Second Law :

"If a resultant force (F) acts on a body of mass (m), it gains it an acceleration (a), and the direction of this acceleration is in the same direction as the acting force."

Acceleration:

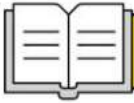
The amount of change in the body's speed during a unit of time (the time rate of change in speed).

Important Note:

- Force and acceleration are vector physical quantities (have magnitude and direction).
- Mass is a scalar physical quantity (has magnitude only).

$$F = m \times a$$

force
mass
acceleration



Problem:

Calculate the magnitude of the resultant force acting on a car of mass 1200 kg, to make it move with an acceleration of magnitude 3 m/s².

Solution: Using the formula: $F = m \times a$

Substituting the values: $F = 1200 \times 3$

The result: $F = 3600$ (N).

Relationship between Acceleration and Force:

The acceleration with which the body moves increases with the increase of the force acting upon it (when the mass is constant) (direct relationship).

Relationship between Acceleration and Mass

The acceleration with which the body moves decreases with the increase of the body's mass (when the force is constant) (inverse relationship).

Security and Safety Precautions

- Upon the occurrence of a sudden stop of the car, the driver will collide with the steering wheel or the windshield according to Newton's first law (Law of Inertia).
- Seatbelt : Works on reducing the rush of the driver to the front towards the steering wheel upon the sudden stop of the car.
- Airbag : Inflates quickly upon collision which works on increasing the time of collision and consequently reducing the rate of change in speed which reduces the collision force acting on the driver.



Newton's Third Law (Law of Action and Reaction)

The Rule: Forces in nature always exist in the form of pairs (action and reaction).



Practical Activity: Balloon Thrust

- The Experiment:** A balloon is inflated and taped to a juice straw passing through a taut string, then the air is left to exit.
- Observation:** Upon the launching of air from the mouth of the balloon in a direction (left), the balloon rushes forcefully in the opposite direction (right).

Analysis:

- Action: Is the force of air thrust backward.
- Reaction: Is the force of balloon thrust forward.



Conclusions:

- Action and reaction happen at the same instant (there is no time difference).
- The two forces are equal in magnitude and opposite in direction.
- The two forces act on two different bodies (the air and the balloon).

Newton's Third Law

- For every action there is a reaction equal to it in magnitude and opposite to it in direction.

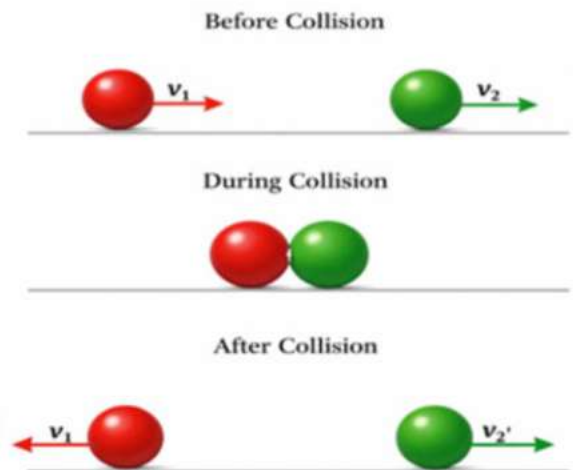
Q: Why do action and reaction not cancel each other? / If the two forces were equal in magnitude and opposite in direction, then why does one not cancel the other and equilibrium occurs?

- A: For two forces to cancel each other (according to the first law), they must act on one body. As for the third law: the force of action acts on a body, and the force of reaction acts on another different body. And since the effect falls on two different bodies, they never cancel each other's effect.

Effect of Collisions on Change of Speed

First Case: Collision of two bodies having the same mass and speed

- When two bodies moving towards each other collide (two opposite directions) and have the same mass and same speed, and assuming no loss of any energy:
- The Result: Each body of them rebounds in the reverse direction to its original direction and with the same magnitude of its previous speed.
- The Reason: Each of them acquiring an "acceleration" as a result of changing the direction of motion, and the direction of this acceleration is in the same direction as the force that acted on each body during collision.



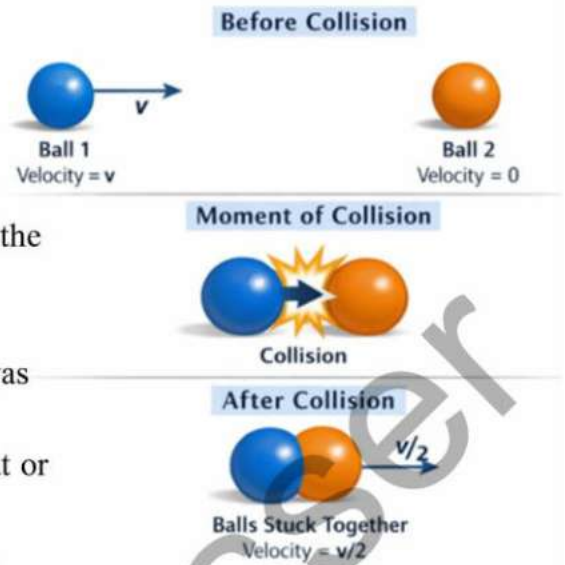
Second Case: Collision of a moving body with a static body

- When a moving body collides with another static body (having the same mass).
- Two forces equal in magnitude and opposite in direction arise between them.
- The Result: The body that was moving stops completely (becomes static), while the body that was static starts moving with the same magnitude of speed of the first body before collision. This is known as Elastic Collision.

Elastic Collision:

It is the case in which collision occurs without any part of energy being lost

- When a moving body collides with another static body, the speed of the moving body decreases, and the static body starts moving, then the two bodies move together as one mass after collision at half the speed that the first body was moving with (assuming equality of their masses).
- Energy Loss: A loss in energy occurs in the form of heat or sound or occurrence of deformation in the shape of the bodies. This type of collision is called Inelastic Collision.



Inelastic Collision:

It is the case in which collision occurs and a part of energy is lost



Life Application: The Flying Water Ski (Flyboard)

- A practical application from our life on Newton's third law (Action and Reaction).
- Action: Is the thrust of water with great force through the openings of the water ski towards the bottom (downwards).
- Reaction: Is the equal force that pushes the user and the ski to fly in the air towards the top (upwards).



Technological Application: Unmanned Aerial Vehicles (Drones)

- A modern technical application on Newton's third law (Action and Reaction).
- Action: The engines of the plane push the air forcefully towards the bottom.
- Reaction: This is followed by the air pushing the plane towards the top with a force equal to the force of thrust downwards, which allows it to fly and stabilize



Lesson One: Questions

Multiple Choice Questions

1. The scientist who proved Aristotle wrong regarding the tendency of objects to rest is:
 (a) Newton (b) Galileo (c) Einstein (d) Archimedes
2. The resultant force of a group of balanced forces acting on an object equals:
 (a) Sum of forces (b) Value of the largest force (c) Zero (d) Value of the largest force
3. The unit of measurement for force in the International System is:
 (a) Kilogram (b) Meter/second (c) Newton/kilogram (d) Newton
4. Passengers rush forward when the bus stops suddenly due to:
 (a) Inertia (b) Friction force (c) Gravity (d) Resultant force
5. As the mass of an object increases, its inertia:
 (a) Decreases (b) Increases (c) Remains constant (d) Vanishes
6. The acceleration with which an object moves is directly proportional to:
 (a) Mass (b) Time (c) Resultant force (d) Initial velocity
7. Newton's third law is called the law of:
 (a) Inertia (b) Action and Reaction (c) Universal Gravitation (d) Uniform Motion
8. The forces of action and reaction are always:
 (a) Equal in magnitude (b) Different in magnitude
 (c) In the same direction (d) Acting on the same body
9. The airbag in cars works to:
 (a) Increase inertia (b) Decrease collision time
 (c) Increase collision time (d) Increase car speed
10. When a balloon explodes and air rushes out backward, the balloon pushes forward in application of the law of:
 (a) Newton's First (b) Newton's Second (c) Newton's Third (d) Universal Gravitation
11. In an inelastic collision, a loss of energy occurs in the form of:
 (a) Inertia (b) Potential energy (c) Mass (d) Heat
12. The "Cruise Control" device in cars is an application of the law of:
 (a) Newton's First (b) Newton's Second (c) Newton's Third (d) Inertia only

13. The unit of measurement for acceleration is:

- (a) N (b) kg (c) m/s^2 (d) N/kg

14. If a force of 10 Newtons acts on a body of mass 2 kg, the acceleration equals:

- (a) m/s^2 (b) 5 m/s^2 (c) 0.2 m/s^2 (d) 12 m/s^2

15. In the game of "Flyboard," the rush of water downward represents:

- (a) Reaction (b) Action (c) Inertia (d) Acceleration

16. Unmanned aerial vehicles (Drones) rely for their flight on the law of:

- (a) Newton's First (b) Newton's Second
(c) Newton's Third (d) Conservation of Matter

17. Newton's theories continued to dominate science for a period of:

- (a) One century (b) Two centuries (c) 3 centuries (d) 5 centuries

Fill in the Blanks

1. The scientist believed that objects tend to rest by nature, while the scientist proved the error of that.
2. The resultant force is a physical quantity and is measured in the unit of
3. The inertia of an object increases with the increase of its
4. For every action, there is a reaction equal to it in and opposite to it in
5. are used in cars to reduce the force of collision by increasing its time.

Write Scientific Term

1. The property of an object resisting the change of its kinetic state from rest or motion.
2. The total force resulting from a group of forces acting on an object at a single moment.
3. Forces equal in magnitude and opposite in direction, their line of action is one, and their resultant is zero.
4. An object remains in its state of rest or uniform motion unless acted upon by an external force that changes its state.
5. The resultant force acting on an object equals the time rate of change in its momentum.
6. For every action, there is a reaction equal to it in magnitude and opposite to it in direction.
7. The amount of change in an object's velocity per unit of time.

8. A device that maintains the stability of the car's speed without direct intervention from the driver.
9. A safety means that inflates with air quickly when a collision occurs to reduce its effect on the driver.
10. A type of collision where no loss in the kinetic energy of the colliding objects occurs.
11. A type of collision where a loss in energy occurs in the form of heat, sound, or deformation.

Fourth: Mark (✓) or (X) with correction

1. The inertia of heavy objects is less than the inertia of light objects.
2. The resultant force of two forces equal in magnitude and in the same direction equals zero.
3. Newton's First Law explains the rush of passengers forward when the car stops suddenly.
4. Acceleration is inversely proportional to the force acting on the object.
5. The forces of action and reaction always act on one object.
6. In an elastic collision, the total kinetic energy remains conserved.
7. The seat belt prevents inertia from affecting the passengers.
8. If the resultant force does not equal zero, then the object moves with acceleration.
9. The stopping distance of a truck increases with the increase of its mass when pressing the brakes.
10. The game of air hockey relies on reducing friction to maintain the kinetic state.
11. The rush of a rocket upwards depends on Newton's Third Law.

Give Reasons (Explain)

1. Bus passengers rush forward when it stops suddenly.
.....
2. The necessity of using seat belts in cars and planes.
.....
3. The stopping distance for large trucks increases compared to small cars despite moving at the same speed.
.....
4. The forces of action and reaction do not cause equilibrium for the object.
.....

5. Equipping cars with airbags.

6. The fruit dish remains in its place when pulling the tablecloth from underneath it at great speed.

7. The continued rotation of fan blades for a short period after cutting off the electric current.

What Happens When...

1. Increasing the force acting on an object to double with its mass remaining constant.

2. Increasing the mass of an object to double with the force acting on it remaining constant.

3. The resultant force acting on an object moving with uniform velocity vanishes.

4. Pulling a tablecloth from under a stationary object at very high speed.

5. The occurrence of an inelastic collision between two cars.

Comparisons

1. Newton's First Law and Newton's Second Law

2. Elastic Collision and Inelastic Collision

Essay Questions

1. Calculate the resultant force necessary to give an object of mass 50 kg an acceleration of 4 m/s^2 .

2. An object is acted upon by a force of 100 Newtons, giving it an acceleration of 2 m/s^2 . Calculate its mass.

3. Mention three technological or life applications of Newton's Third Law.

4. Problem: A car of mass 1200 kg moves at a uniform velocity. What is the magnitude of the resultant force acting on it? And why?

5. Explain the role of the airbag in protecting the driver using Newton's Second Law.

6. Two forces acted on an object of mass 10 kg, the first 30 Newtons East and the second 20 Newtons West. Calculate the acceleration and its direction.

7. How does the "Cruise Control" device work in modern cars?

8. How does this device apply Newton's Third Law?



2

Levers

- Technological progress led to the use of machines to assist humans in performing arduous tasks that require great force.
- The Tower Crane (Winch) is considered an example of a compound machine, which is a machine consisting of many simple machines working together.

Discuss this lecture

The lecture includes the definition of levers, their law, types, and their importance in facilitating work.

Simple Machines



Fig. (2) Claw Hammer

Multiplies force to remove nails from wood.



Fig. (3) Tweezers

Used for precision and delicate work.



Fig. (4) BBQ Tongs

Used to avoid the risk of burns.



Fig. (5) Pulley

Changes the direction of force to lift or lower weights.

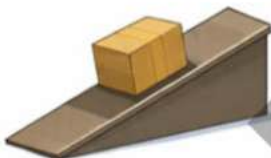


Fig. (6) Inclined Plane

Used to save effort.



Fig. (7) Wheel and Axle

Multiplies force or increases speed.



Fig. (8) Wedge

Changes the direction of the applied force.



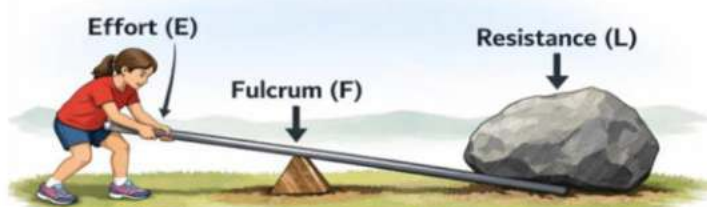
Fig. (9) Gears and Belts

Transmit motion and change speed, like in bicycles.

Levers:

It is a rigid bar (straight or curved) that moves around a point on it called the Fulcrum (axis of rotation) F , and is acted upon during use by a Force E and a Resistance (Load) L (Effort)

- Fulcrum: It is the fixed point around which the rigid bar of the lever rotates.
- Resistance (Load): The weight or object intended to be moved or acted upon by the lever.





Law of Levers

Activity 2: Practical

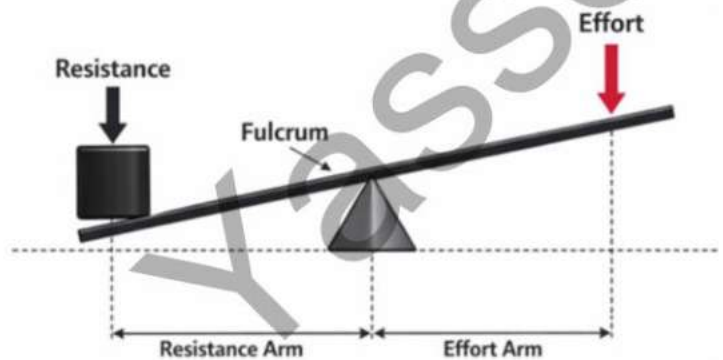
1. Suspend a weight at a distance of 2 cm to the right of the number balance fulcrum.
 - The balance tilts to the right side.
2. Suspend a similar weight at a distance of 5 cm to the left of the fulcrum.
 - The balance remains tilted to the right side, because the weight closer to the fulcrum does not equivalent [balance out] the farther weight.
3. Move the weight that is on the right to become at a distance of 5 cm from the fulcrum.
 - The balance equilibrates, as the two equal weights become at equal distances from the fulcrum.

Resistance Arm:

- It is the distance between the weight representing the resistance and the fulcrum.

Force Arm:

- It is the distance between the acting force and the fulcrum.

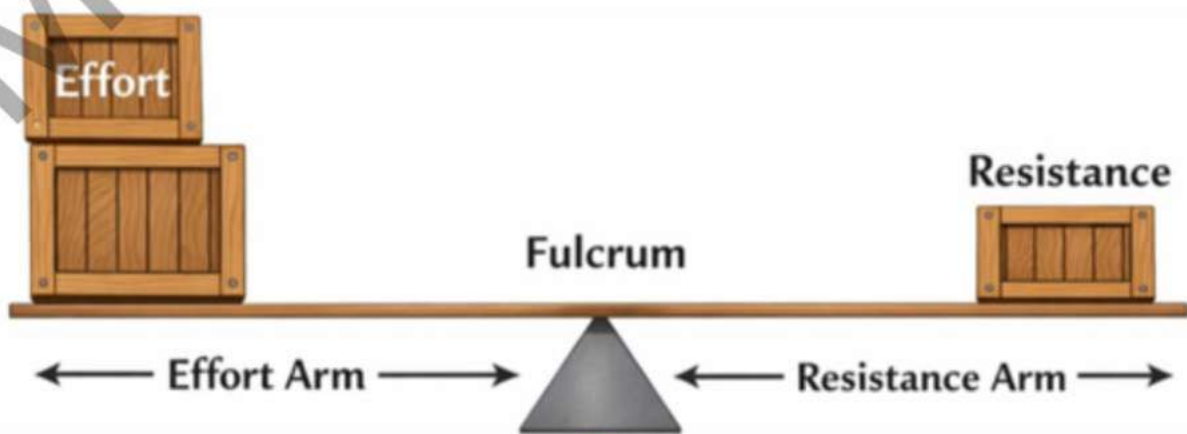


Levers :

The lever is in a state of equilibrium when the product of the force multiplied by its arm is equal to the product of the resistance multiplied by its arm.

$$\text{Force} \times \text{Force Arm} = \text{Resistance} \times \text{Resistance Arm}$$

- The product of the force multiplied by its arm is called the Torque of Force (or Moment of Force).
- The product of the resistance multiplied by its arm is called the Torque of Resistance (or Moment of Resistance).
- Meaning that the lever is in a state of equilibrium when the torque of force equals the torque of resistance.



Mechanical Advantage of the Lever:

The extent to which the lever saves effort is indicated through the concept of mechanical advantage, which is estimated from the following relationship:

$$\text{Mechanical Advantage} = \text{Resistance} / \text{Force} = \text{Length of Resistance Arm} / \text{Length of Force Arm}$$

- The machine provides effort saving when the value of its Mechanical Advantage is greater than 1.
- Increasing the length of the Force Arm leads to reducing the force required to lift the same weight.

Example : A weight of mass 2 kg was suspended 15 cm to the right of a lever's fulcrum, and another weight weighing 30 N representing the resistance was suspended to the left of the fulcrum at a distance of X cm, so the lever became in a horizontal position. (Given that the acceleration due to gravity equals 10 m/s²).

Calculate:

1. The value of the magnitude (X).
2. The Mechanical Advantage of this lever.

Step One: Calculating the Force (Weight) The mass of the weight suspended on the right must first be converted to weight (force) using the weight law:

$$\text{Weight (W)} = \text{Mass (m)} \times \text{Acceleration gravity (g)} = 2 \times 10 = 20$$

Step Two : Calculating the Resistance Arm (X) using the Law of Levers

$$\text{Force} \times \text{Force Arm} = \text{Resistance} \times \text{Resistance Arm}$$

$$\text{Force} = 20 \text{ N}$$

$$\text{Force Arm} = 15 \text{ cm}$$

$$\text{Resistance} = 30 \text{ N}$$

$$\text{Resistance Arm (X)} = ?$$

$$\text{Resistance Arm (X)} = 10 \text{ cm.}$$

Step Three : Calculating the Mechanical Advantage $30 / 20 = 1.5$

Conclusion : Since the Mechanical Advantage (1.5) is greater than 1, this lever saves effort.



Types of Levers

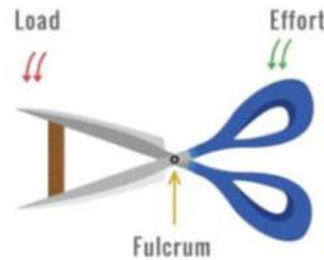
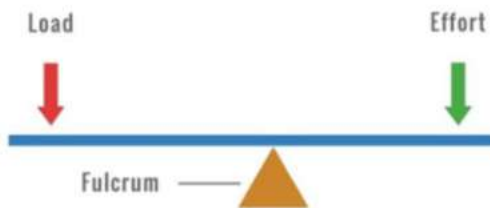
- The type of lever and its importance are determined according to the relative position of the Force (E), the Resistance (L), and the Fulcrum (F).

1. First Class Lever

- **Definition:** It is the lever in which the Fulcrum (F) is located between the Force (E) and the Resistance (L).
- **Examples:** Pliers, scissors, seesaw, and crowbar.

Important Note: All first-class levers change the direction of the force, but regarding saving effort: some save effort, and others do not save effort (depending on the position of the fulcrum).

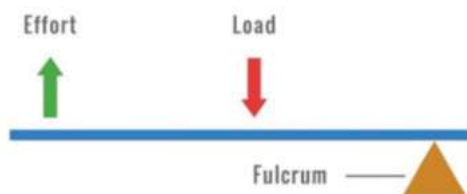
First Class



2. Second Class Levers:

- **Definition:** These are levers in which the point of resistance application lies between the fulcrum and the point of force application.
- **Examples:** Wheelbarrow, nutcracker, and lemon squeezer.
- **Important Note:** All second-class levers always save effort; the reason is that the Force Arm in them is always longer than the Resistance Arm.

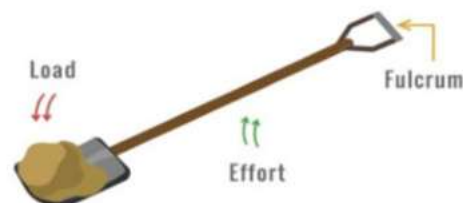
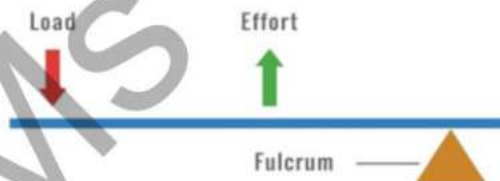
Second Class



3. Third Class Levers:

- **Definition:** These are levers in which the point of force application lies between the fulcrum and the point of resistance application.
- **Examples:** Tennis racket, manual broom, and coal holder (tongs) or tweezers.
- **Important Note:** These levers do not save effort, but they are used for precise or hazardous work.

Third Class



Integration with Biology (Levers in the Human Body)

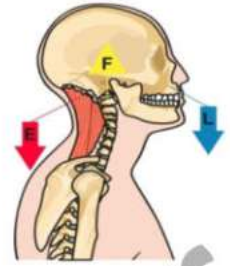
The Skeletal System acts as a system of levers:

- Bones represent the levers.
- Joints represent the fulcrums.
- Muscle contraction force represents the Force.
- The weight to be overcome represents the Resistance.



The Head (First Class Lever)

- The meeting point of the skull with the spinal column represents the Fulcrum. The posterior neck muscles represent the Force pulling the head backward, while the weight of the head (the front part) represents the Resistance tilting it forward. The goal is to maintain balance so the head remains upright.



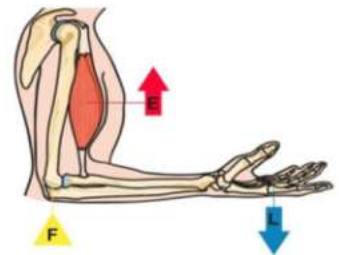
The Foot when standing on tiptoes (Second Class Lever)

- Fulcrum: The tips of the toes touching the ground.
- Resistance: The entire body weight pressing in the middle.
- Force: The posterior leg muscles (calf) lifting the heel upward.
- Since the Resistance (Weight) is in the middle, it is a second-class lever.



The Upper Arm / Forearm (Third Class Lever)

- Fulcrum: The elbow joint.
- Force: The Biceps muscle (upper arm muscle).
- Resistance: The weight carried in the palm of the hand.
- Since the Force is located between the Fulcrum and the Resistance, it is a third-class lever.



Lesson Two: Questions

Multiple Choice Questions

1. Which of the following machines is considered a first-class lever?
 (a) Nutcracker (b) Wheelbarrow (c) Scissors (d) Coal tongs
2. In second-class levers, the is located in the middle.
 (a) Force (b) Resistance (c) Fulcrum (d) Force arm
3. The nutcracker is considered a lever of the:
 (a) First class (b) Second class (c) Third class (d) Fourth class
4. The distance between the force and the fulcrum is called:
 (a) Resistance arm (b) Displacement (c) Moment (d) Force arm
5. Third-class levers do not always save effort because:
 (a) Force arm > Resistance arm (b) Force arm < Resistance arm
 (c) Force = Resistance (d) Fulcrum is in the middle
6. The wheelbarrow always saves effort because it is a lever of the:
 (a) First class (b) Second class (c) Third class (d) Compound
7. The law of levers at equilibrium states:
 (a) Force $\times$ its arm = Resistance $\times$ its arm (b) Force + Resistance = Zero
 (c) Force $\times$ Resistance = Force arm (d) Force $\div$ its arm = Constant
8. If the force arm is longer than the resistance arm, the lever:
 (a) Does not save effort (b) Is always balanced (c) Saves effort (d) Does not move
9. The bones of the head and neck in the human body act as a lever of the:
 (a) First class (b) Second class (c) Third class (d) Not considered a lever
10. In which of the following levers can the force arm equal the resistance arm?
 (a) Coal tongs (b) Wheelbarrow (c) Seesaw (d) Nutcracker
11. The foot bone represents a lever of the:
 (a) First class (b) Second class (c) Third class (d) Compound
12. In a manual broom, the lower hand is the:
 (a) Resistance (b) Weight (c) Axis of rotation (d) Force

13. If the force is 50 Newtons and its arm is 10 cm, and the resistance is 100 Newtons, for the lever to balance, the resistance arm must be:

- (a) 5 cm (b) 10 cm (c) 20 cm (d) 50 cm

14. The lever used to increase speed is of the:

- (a) First class (b) Second class (c) Third class (d) All of the above

15. Which of the following machines is a "compound machine"?

- (a) Tower crane (b) Crowbar (c) Scissors (d) Tweezers

16. The human arm is considered a lever of the:

- (a) First class (b) Second class (c) Third class (d) Fourth class

17. When the acting force is smaller than the resistance, the lever:

- (a) Saves effort (b) Does not save effort (c) Breaks (d) Stops

18. All of the following are functions of levers except:

- (a) Magnifying force (b) Transferring force (c) Reducing speed (d) Accuracy in work

19. For a lever to save effort, the ratio between the force arm and the resistance arm must be:

- (a) Equal to 1 (b) Greater than 1 (c) Less than 1 (d) Zero

20. The lever where the force is between the resistance and the fulcrum is:

- (a) Scissors (b) Soda bottle opener (c) Crowbar (d) Sweet tongs

21. If the length of the force arm is half the length of the resistance arm, the force is:

- (a) Half the resistance (b) Double the resistance
(c) Equal to resistance (d) Quarter of resistance

22. The common balance (two-pan scale) is an example of a lever that:

- (a) Does not save effort (b) Always saves effort
(c) Increases speed (d) Increases distance

23. In second-class levers, the force is always the resistance.

- (a) Greater than (b) Equal to (c) Smaller than (d) Double

Fill in the Blanks

1. A lever consists of a rigid bar acted upon by and and rotates around a fixed point.

2. The class of levers always saves effort, while the class never saves effort.

3. The force arm is the distance between and
4. Tweezers and coal tongs are levers of the class, while the nutcracker is a lever of the class.
5. In the human body, the head and neck bones represent a lever of the class, and the foot bones represent a lever of the class.
6. The force can equal the resistance only in levers of the class.

Write Scientific Term

1. A rigid bar that moves around a fixed point and is acted upon by a force and a resistance.
2. The fixed point on which the lever rotates.
3. The distance between the fulcrum and the point of force application.
4. The distance between the fulcrum and the point of resistance application.
5. Levers where the fulcrum is located between the force and the resistance.
6. Levers where the resistance is located between the force and the fulcrum.
7. Levers where the force is located between the resistance and the fulcrum.
8. The product of the force multiplied by its arm.
9. Levers used for accuracy in work or avoiding dangers and do not save effort.
10. The weight intended to be moved by the lever.

Mark (✓) or (X) with correction

1. All levers work to save effort.
2. The wheelbarrow is a second-class lever and always saves effort.
3. In third-class levers, the force arm is always smaller than the resistance arm.
4. First-class levers can save effort if the force arm is larger than the resistance arm.
5. Tweezers are used to magnify force.
6. If the force arm equals the resistance arm, the lever does not save effort.
7. The nutcracker is a first-class lever.
8. In the state of lever equilibrium, the moment of force equals the moment of resistance.
9. The crowbar saves effort because the force arm in it is smaller than the resistance arm.
10. In the skeletal system, the joint represents the fulcrum.

Give Reasons (Explain)

1. Second-class levers always save effort.

2. Third-class levers never save effort.

.....

3. Although some levers do not save effort, they are useful to humans.

.....

4. First-class levers can save effort or not save it.

.....

5. Scissors are considered a first-class lever.

.....

6. The wheelbarrow is considered a second-class lever.

.....

7. The force arm in sweet tongs is smaller than the resistance arm.

.....

8. The force is always smaller than the resistance in the nutcracker.

.....

What Happens When...

1. Increasing the length of the force arm over the length of the resistance arm in a lever.

.....

2. The length of the force arm equals the resistance arm.

.....

3. The presence of resistance between the force and the fulcrum.

.....

4. The presence of force between the resistance and the fulcrum.

.....

5. Applying a small force on the long arm of a crowbar.

.....

6. Moving the fulcrum in a first-class lever to be very close to the force.

.....

Comparisons

1. First-class levers and Second-class levers

.....

2. Crowbar and Sweet Tongs (regarding type and benefit)

.....

Essay Questions

1. A first-class lever, the force acting on it is 50 Newtons and its arm length is 20 cm, acts on a resistance of 200 Newtons. Calculate the length of the resistance arm necessary for the lever's equilibrium.

.....

2. Mention the functions of levers.

.....

3. Problem: A lever has a force arm length of 40 cm and a resistance arm length of 10 cm. Does this lever save effort? And why?

.....

4. Classify the following machines according to lever type: (Seesaw - Soda bottle opener - Tweezers).

.....

5. Problem: If the force acting on a lever is 400 Newtons and the resistance is 100 Newtons, and the resistance arm is 20 cm. Calculate the force arm.

.....

6. Explain how the skeletal system works as a lever system (mentioning an example).

.....

7. Problem: A balanced lever, its total length is 100 cm, the fulcrum is exactly in the middle. A resistance of 60 Newtons was hung at one end. What is the magnitude of the force needed at the other end to cause equilibrium?

.....

8. Observe the image shown before you then answer:

a) What is the mechanical benefit of using this tool?

b) Classify this type of lever.

c) Does this lever save effort? And why do we use it?

.....



9. Observe the figure before you then answer:

- a) This figure represents a lever of which type?
 - b) What represents the "Resistance" in this figure?
 - c) Where is the fulcrum located?
-



Ms. Doaa Yasser



unit 3

Reproduction in living organisms

- **Lesson One: Cell Division**
- **Lesson two: floral reproduction**

1

Cell Division

- One of the most important vital processes that occur in living organisms, whether they are unicellular or multicellular.
- Necessary for the growth of the living organism, compensating for damaged or lost cells, and completing the reproduction process in some organisms.
- Depends on the genetic material existing inside the cell nucleus, which consists of chromosomes.

Discuss this lecture ✕

The concept of the cell and its importance, cell types, and asexual reproduction, with an explanation of mitosis and meiosis in growth, reproduction, and genetic diversity.

Types of Cells in Living Organisms

Somatic Cells	Reproductive Cells
Like skin cells, liver, muscles.	Like: Testis and Ovary in humans and animals. Anther and Ovary in plants.
Contain the complete number of chromosomes ($2n$).	Contain the complete number of chromosomes ($2n$).
Depend on Mitotic division.	Depend on Meiotic division to produce gametes.

Gametes or Sex Cells

- Produced from gonad cells by meiotic division and contain half the number of chromosomes (n).

Like

Sperms and Ovums (eggs) in humans and animals and Pollen grains and Ovums in plants.

For example:

The somatic cell in humans contains ~~46~~ chromosomes ($2n=46$), while the gamete (sperm or ovum) contains ~~23~~ chromosomes ($n=23$).

Reproduction:

- It is a vital process aiming to produce new individuals of the same species to guarantee its continuity and protect it from extinction.

Asexual Reproduction (Non-mating)

- It is the process of producing new individuals from one parental individual only, without the need for specialized reproductive systems or gametes.

Characteristics of Asexual Reproduction

1. Occurs through one parent.
2. Depends on **Mitotic Division** of cells.
3. Produces a large number of offspring in a relatively short time.
4. Does not lead to genetic variation among the resulting individuals.
5. Does not require specialized reproductive organs or structures (mostly).
6. Resulting individuals are completely identical to the parent in genetic traits (carrying an exact copy of the parent's genetic material).
7. **Common in unicellular organisms** (like Amoeba, Bacteria, Yeast fungus) and some multicellular organisms (like Hydra, Starfish, some plants).



Vegetative Reproduction (An example of Asexual Reproduction)

Occurrence:

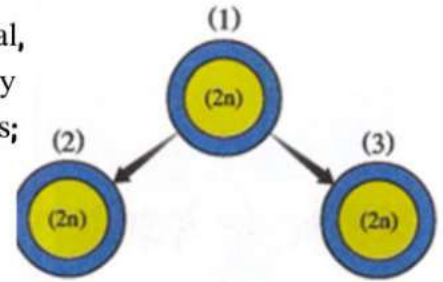
- Occurs in some plants without the need for seeds.
- Potato tubers are considered a clear example of vegetative reproduction.
- How it grows: When a piece of the tuber is placed in suitable conditions, the bud becomes active to form a small stem growing upwards carrying leaves, and at the same time, primary roots form extending into the soil.
- Function of the tuber: The tuber piece acts as a store for energy (stored food) to supply the stem and roots with the necessary growth in the beginning.
- Transformation into a full plant: With the development of roots to absorb water and salts, and the rising of the stem and leaves towards the light, the new plant becomes capable of making its own food via the photosynthesis process.

Types of Cell Division

- There are two main types of cell division: Mitotic Division and Meiotic (Reduction) Division.

First: Mitotic Division

- In it, one cell ($2n$) divides into two new cells ($2n$) that are identical, which involves distributing a complete and exactly matching copy of the genetic information of the original cell to the two new cells; that is why it is called Equal Division.
- Asexual reproduction depends on the occurrence of mitotic division, which involves creating an exact copy of the parental individual.



Place of occurrence:

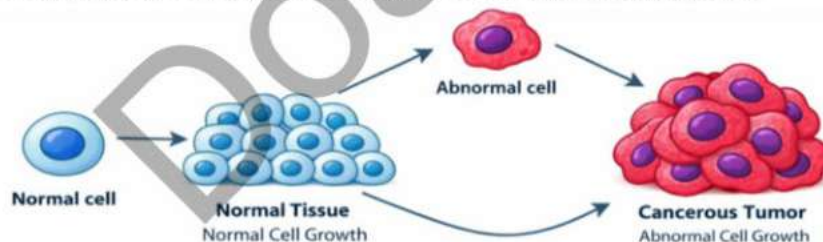
- Occurs in all somatic cells of higher living organisms (except nerve cells and mature red blood cells in mammals, because they do not contain a nucleus).

Its Importance:

1. Growth of the living organism: Increasing the number of cells allows the growth of the organism from childhood to adulthood.
2. Compensating for dead and damaged tissues: Such as the healing of skin wounds, blood vessels, and bone fractures.
3. Completing the process of asexual reproduction: In some unicellular organisms and some multicellular organisms that reproduce asexually.

Integration with Medical Science: Cancer Tumor

- Cancer is a disease resulting from the continuous and abnormal mitotic division of some body cells, leading to the formation of a mass of cells called a cancerous tumor.



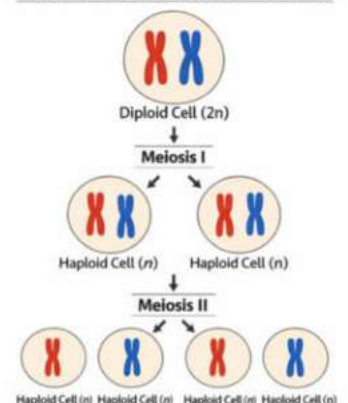
Second: Meiotic (Reduction) Division

- In it, one cell divides into four cells, each containing half the number of chromosomes (n) existing in the original cell ($2n$); that is why it is called Reduction Division.

Steps of Meiotic Division:

- First Meiotic Division: Results in two cells, each containing half the original number of chromosomes (n).
- Second Meiotic Division: It is a mitotic division, resulting in four cells, each having half the original number of chromosomes (n), then each transforms into a sperm, ovum, or pollen grain.

Meiotic Division (Reduction Division)



Place of occurrence:

- Occurs in Reproductive Cells (Gonad cells) in higher living organisms that reproduce sexually. Such as testis cells in the male to produce sperms, ovary cells in the female to produce ovums, anther cells in plants to produce pollen grains, and ovary cells in plants to produce ovums.

Its Importance:

- Formation of Gametes (Sex Cells): Necessary for completing the sexual reproduction process.

Give Reason (Why): Mitotic division is important for a child's body, unlike Meiotic division.

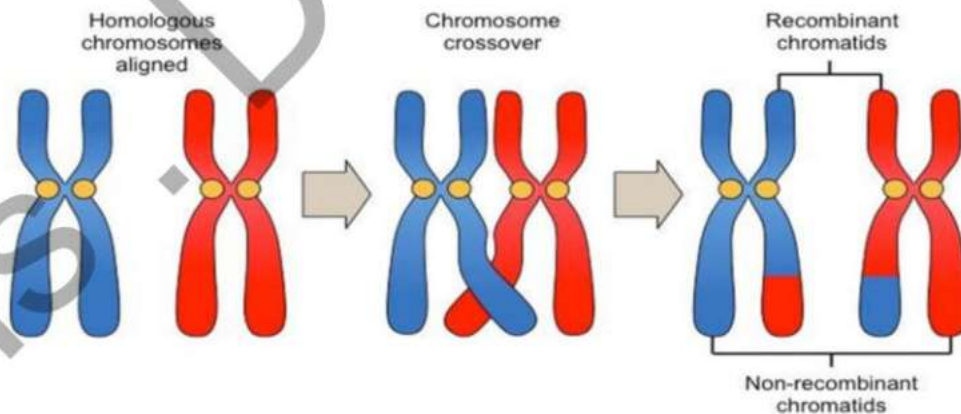
- Because: Mitotic division leads to growth which the child's body needs and compensates for damaged and lost cells when a wound or bone fracture occurs, whereas Meiotic division leads to the formation of gametes which are needed by adults only to complete sexual reproduction.

Genetic Diversity :

- Meiotic division is characterized by producing genetically different cells, as the process of Genetic Crossing Over occurs between homologous chromosomes during the first meiotic division, and this process allows for the diversity of genetic traits in individuals of the same species.

Crossing Over Phenomenon:

It is a process of exchanging genes between the two inner chromatids of the tetrad



Its Importance: The crossing over phenomenon works on the diversity of genetic traits in individuals of the same species... Why?

- Because in it, an exchange of genes carrying genetic traits in the DNA molecule takes place between the two inner chromatids of the two homologous chromosomes in every tetrad

1. If the number of chromosomes in a human liver cell is 46 chromosomes, then the number of chromosomes in a sperm cell of the same person equals

- (a) 46 (b) 23 (c) 92 (d) 22

2. Which of the following cells never divides in the human body?

- (a) Liver cells (b) Skin cells (c) Mature red blood cells (d) Bone cells

3. The process of gamete formation in plants (such as pollen grains) depends on

- (a) Meiosis (b) Mitosis (c) Vegetative reproduction (d) Budding

4. The phenomenon of genetic crossing over occurs between

- (a) Sister chromatids (b) Non-sister chromatids
(c) Non-homologous chromosomes (d) Somatic cells

5. The ratio between the number of chromosomes in the cell resulting from mitosis and the original cell is

- (a) 1:2 (b) 2:1 (c) 1:1 (d) 1:4

6. All of the following organisms reproduce asexually by mitosis except

- (a) Amoeba (b) Bacteria (c) Yeast fungus (d) Human

7. A cancerous tumor arises as a result of

- (a) Abnormal mitotic division
(b) Abnormal meiotic division
(c) Cessation of cell division
(d) Crossing over phenomenon

8. If a wound occurs in human skin, it is compensated for by

- (a) First meiotic division (b) Second meiotic division (c) Mitosis (d) Fertilization

9. The number of cells resulting from the complete meiotic division of one reproductive cell is

- (a) Two cells (b) 4 cells (c) 8 cells (d) One cell

10. The main source of genetic diversity in higher organisms is

- (a) Mitosis (b) Asexual reproduction (c) Growth (d) Crossing over phenomenon

11. Asexual reproduction produces individuals that are

- | | |
|---------------------------------------|--------------------------------|
| (a) Genetically different | (b) Identical to the parent |
| (c) Contain half the genetic material | (d) Resulting from two parents |

12. Meiosis occurs in flowering plants in the

- | | | | |
|------------|----------|----------|------------|
| (a) Anther | (b) Stem | (c) Root | (d) Leaves |
|------------|----------|----------|------------|

13. When planting a piece of a potato tuber, it must contain to ensure growth.

- | | | | |
|-----------|----------|-------------|-----------|
| (a) Roots | (b) Buds | (c) Flowers | (d) Seeds |
|-----------|----------|-------------|-----------|

14. Which of the following is considered a function of mitosis?

- | | |
|----------------------|------------------------------|
| (a) Gamete formation | (b) Genetic diversity |
| (c) Wound healing | (d) Reduction of chromosomes |

15. The number of chromosomes in a human female ovum is

- | | | | |
|--------|--------|--------|--------|
| (a) 46 | (b) 23 | (c) 44 | (d) 22 |
|--------|--------|--------|--------|

16. The division that leads to the growth of a child from childhood to adulthood is

- | | | | |
|-------------------|--------------------|-------------|--------------------|
| (a) First Meiosis | (b) Second Meiosis | (c) Mitosis | (d) Binary fission |
|-------------------|--------------------|-------------|--------------------|

17. Vegetative reproduction is considered a type of reproduction.

- | | | | |
|-------------|----------------------|------------|-------------|
| (a) Asexual | (b) Gamete-dependent | (c) Sexual | (d) Meiotic |
|-------------|----------------------|------------|-------------|

18. The cells resulting from meiosis are called

- | | | | |
|------------|------------|-------------|-------------|
| (a) Zygote | (b) Embryo | (c) Tissues | (d) Gametes |
|------------|------------|-------------|-------------|

19. Which of the following is "NOT" considered a characteristic of asexual reproduction?

- | | |
|--------------------------------|-----------------------------|
| (a) Occurs via one parent | (b) Provides many offspring |
| (c) Achieves genetic diversity | (d) Relies on mitosis |

Fill in the Blanks

1. The male gamete in humans contains chromosomes, while the muscle cell contains chromosomes.

2. division aims to repair damaged tissues, while division aims to form gametes.

3. Examples of unicellular organisms that reproduce asexually are and

4. The reproductive organs (gonads) in plants are called (for male) and (for female).

5. Asexual reproduction relies on division, while sexual reproduction relies on division.

6. Potatoes reproduce vegetatively via

Write Scientific Term

1. A biological process aiming to produce new individuals of the same species to protect it from extinction.
2. Cells produced from meiosis containing half the number of chromosomes.
3. A disease resulting from the continuous and abnormal mitotic division of body cells.
4. A process of gene exchange between the inner chromatids of the tetrad leading to genetic diversity.
5. Cell division occurring in somatic cells resulting in two identical cells.
6. Reproduction that does not require reproductive systems and relies on a single parent.
7. An underground food-storing stem used in the vegetative reproduction of the potato plant.
8. Division resulting in four cells, each with half the number of chromosomes (n).
9. Cells that contain the full number of chromosomes and divide mitotically.
10. The male reproductive organs (gonads) in humans and animals.
11. The female reproductive organs (gonads) in plants that produce ovules.

Mark (✓) or (X) with correction

1. Asexual reproduction produces individuals genetically different from the parents.
2. The sperm contains the same number of chromosomes found in the ovum.
3. Meiosis occurs in liver and skin cells.
4. The second meiotic division is considered a mitotic division in terms of method and numerical results of chromosomes inside the cell.
5. The phenomenon of crossing over occurs during mitosis and causes genetic diversity.
6. The potato tuber is an adventitious root that stores food.
7. A cancerous tumor results from cells dividing naturally and regularly.
8. Sexual reproduction maintains the genetic consistency of traits.
9. Mitosis aims for the growth of the organism and compensation for damaged parts.
10. Plants can reproduce vegetatively without the need for seeds.

Give Reasons (Explain)

1. Mitosis is called equational division.
-

2. Meiosis is a source of genetic diversity in living organisms.

3. Meiosis is called reduction division.

4. Individuals produced by asexual reproduction are an identical copy of the parent.

5. The importance of mitosis for children is greater than for adults.

6. Vegetative reproduction in potatoes is considered asexual reproduction.

7. The danger of continuous abnormal mitotic division.

What Happens When...

1. A somatic cell divides mitotically.

2. Continuous and abnormal mitotic division occurs in some body cells.

3. The crossing over phenomenon does not occur during meiosis.

4. Planting a piece of a potato tuber that does not contain buds.

5. A reproductive cell (like the testis) divides meiotically.

6. A child suffers a bone fracture (regarding cell division).

Comparisons

1. Mitosis and Meiosis

2. Somatic Cells and Reproductive Cells (Gonads)

3. Asexual Reproduction and Sexual Reproduction

Essay Questions

1. Problem: If the number of chromosomes in a pancreas cell of a rabbit is 44 chromosomes. Calculate the number of chromosomes in: a) Rabbit ovum. b) Rabbit liver cell. c) Rabbit ovary cell.

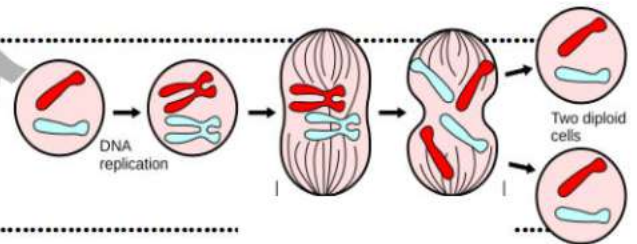
2. How does a potato tuber form and turn into a complete plant?

3. Mention three examples of somatic cells in humans and two examples of reproductive cells (organs).

4. What is cancer? And how does it arise?

5. What is the type of division shown in the figure?

And what is its importance?



6. A reproductive cell in an organism contains 20 chromosomes, it divided meiotically. What is the number of resulting cells and the number of chromosomes in each?

7. What is the importance of Meiosis?

8. What is the name of the phenomenon shown in the figure? And what is its importance?



2

Floral Reproduction

Flowering Plants

- Flowering plants are considered one of the most widely spread types of plants around the world. They are the plants most related to humans, as they constitute a primary source for their food.
- Flowering plants rely on the process of sexual reproduction, which takes place mainly through flowers, to maintain the continuity of their species.

Discuss this lecture ✕

The concept of cell division and its types (mitotic and meiotic), its importance in growth, reproduction, and cell replacement, and its role in gamete formation and achieving genetic diversity.

Origin of the Flower

The flower originates from a vegetative bud modified to perform the process of reproduction.

- Origin:** The flower usually emerges from the axil of a leaf known as the Bract.
- If a part of the plant stem bears more than one flower, this gathering is called an Inflorescence, and the part of the stem bearing these flowers is called the Inflorescence Axis (or Peduncle).

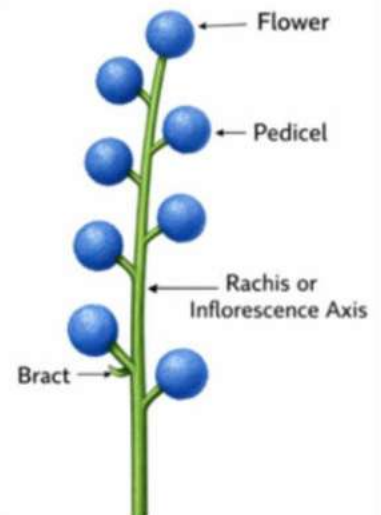


Forms of Inflorescences vary, and they are classified in the text into three main types of simple inflorescences:

1. Simple Racemose Inflorescences

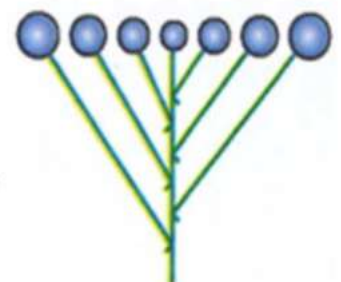
These inflorescences are characterized by the presence of one long main axis that continues to grow. This axis bears flowers in all directions, and each flower is carried on a small stalk.

- Shape:** This arrangement gives the inflorescence a shape resembling a bunch of grapes.
- Blooming:** Flowers bloom from the lower part (older flowers) to the upper part (younger flowers).
- Examples:** Snapdragon plant and Stock plant.



2. Simple Corymbose Inflorescences

These inflorescences are characterized by the presence of one short main axis that stops growing after forming a number of flowers. The flowers grow on the sides of the axis only.



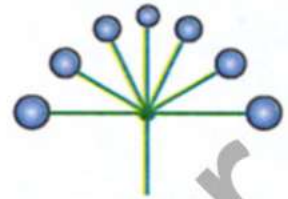
- **Shape:** This arrangement gives the inflorescence a shape resembling a comb.
- **Blooming:** Flowers bloom from the outside (older flowers) to the inside (younger flowers).
- **Level:** Almost all flowers are at one level, distinguishing them from racemose inflorescences.
- **Examples:** Cherry plant and Candytuft (Iberis) plant.



3. Simple Umbellate Inflorescences

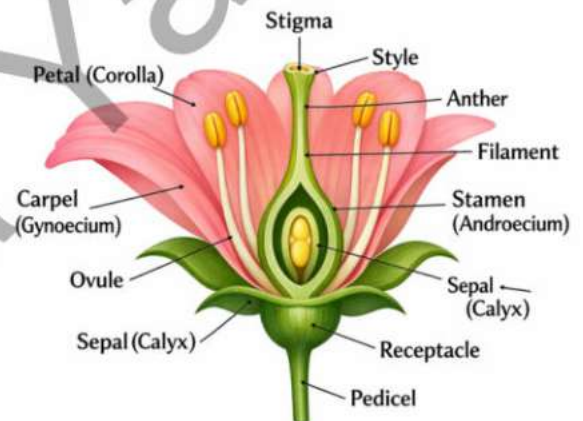
These inflorescences are characterized by all flowers emerging from a single point at the end of the stem.

- **Shape:** This arrangement gives the inflorescence a shape resembling a tent or umbrella.
- **Stalks:** The stalks of the flowers are equal in length.
- **Blooming:** Flowers bloom from the outside (older flowers) to the inside (younger flowers).
- **Examples:** Garlic plant and Onion plant.



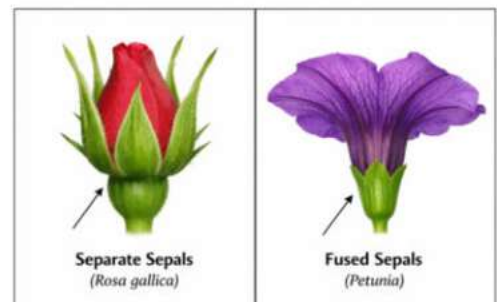
Structure of the Flower

- The flower is the organ of sexual reproduction in flowering plants.
- A typical flower consists of four floral whorls arranged in groups, all carried by a swollen area at the end of the flower stalk called the Receptacle.
- A typical flower consists of four main floral whorls, from the outside to the inside: Calyx, Corolla, Androecium, and Gynoecium.



A. The Calyx

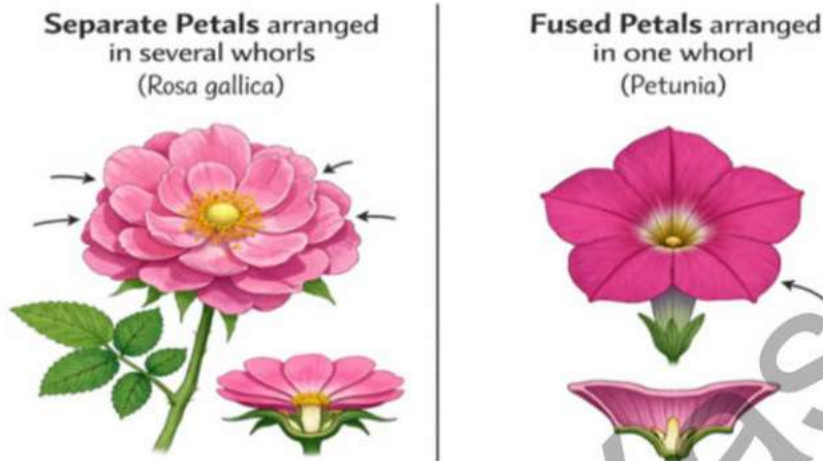
- **Structure:** Consists of green leaves called Sepals. Their number varies from one flower to another.
- **Shape:** Sepals may be separate, as in the Rose flower, or fused, as in the Petunia flower.
- **Function:** Protecting the internal parts of the flower, especially before it blooms.



B. The Corolla

- **Structure:** Follows the calyx from the inside and consists of thin white or colored leaves called Petals. They are often characterized by a pleasant scent (Give reason: to attract insects).

- **Number and Arrangement:** The number of petals is often equal to the number of sepals and alternates with them in position. Petals may be arranged in one fused whorl, as in the Petunia flower, or in several separate and arranged whorls, as in the Rose flower.
- **Function:** Protecting the floral reproductive organs, in addition to attracting insects that play an important role in completing the floral reproduction process (Pollination).



Special Cases in Flower Structure

There are some flowers that differ in their structure from the typical flower in terms of distinguishing the floral whorls:

Narcissus Flower:

Sepals cannot be distinguished from petals in terms of color and shape; the calyx and corolla whorls together are called the Perianth.



Figure (14): Willow flowers

Naked Flowers:

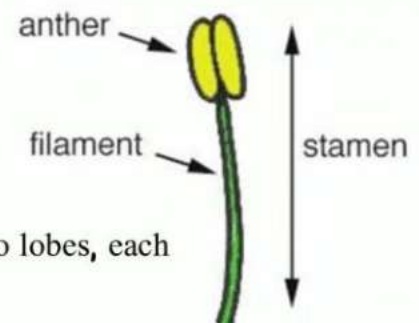
Flowers in which sepals and petals are absent (i.e., there is no calyx or corolla whorl), such as Willow flowers.



Figure (13): Daffodil flower

C. The Androecium - Male Organ

- The Androecium is the third whorl from the inside, following the corolla. It consists of several leaves called Stamens.
- **Structure of the Stamen:**
 - **Filament:** A thin part that carries the anther.
 - **Anther:** A swelling at the end of the filament, often containing two lobes, each containing two sacs filled with pollen grains (male gametes).



D. The Gynoecium - Female Organ

The Gynoecium is the fourth whorl and is found in the center of the flower. It consists of leaves called Carpels, which resemble a flask.

• Structure of the Carpel:

- **Ovary:** A swelling found at the base of the carpel containing ovules (female gametes).
- **Style:** A thin neck connecting the ovary to the stigma.
- **Stigma:** A sticky disc at the end of the style.



Sex of the Flower

The sex of the flower is classified based on the presence or absence of male and female organs in it:

1. Bisexual (Hermaphrodite):

Contains both male and female organs (Androecium and Gynoecium together). Symbol: ♂
 Examples: Tomato and Eggplant flowers.

2. Unisexual:

Contains only one of the reproductive organs.
 Examples: Palm, Corn, Pumpkin flowers.
 Female: Contains the Gynoecium only (without Androecium). Symbol : ♀
 Male: Contains the Androecium only (without Gynoecium). Symbol : ♂.

Integration with Medical Science: Medical Benefits of Flowers

The medical benefits of flowers are numerous due to their content of antioxidants and volatile oils, such as:

1. Chamomile Flowers: Used as a sedative for nerves.
2. Hibiscus Flower: Used to lower high blood pressure.
3. Lavender Flowers: Used to relieve muscle pain and headaches.



Chamomile flowers



Hibiscus flower



Lavender flowers

Entrepreneurship and Health Awareness

Some villages are famous for growing roses, and their petals are used in manufacturing products of economic value such as rose water and rose oil.



Preventive Awareness (Hay Fever):

Hay Fever

Some villages are famous for growing roses, and their petals are used in manufacturing products of economic value such as rose water and rose oil.

- It can be avoided by staying away from areas where the percentage of pollen grains increases.

Pollination and Fertilization in Flowers



First: Pollination

Pollination :

It is the process of the transfer of pollen grains from the anthers of stamens (male organs) to the stigmas of carpels (female organs).

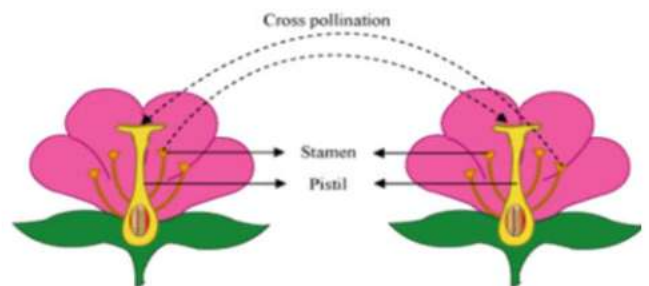


Pollination is divided into two main types:



1. Cross Pollination

It is the transfer of pollen grains from the anther of a flower on a plant to the stigma of another flower on another plant of the same species.



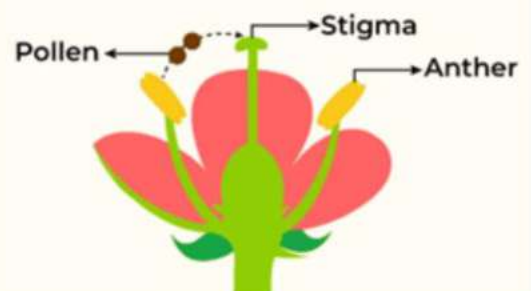
Reasons for occurrence:

- Non-maturation of the Androecium and Gynoecium at the same time.
- Presence of Anthers at a lower level than Stigmas (far from them).
- The flowers being unisexual.



2. Self Pollination

It is the transfer of pollen grains from the anther of a flower to the stigma of the same flower, or to the stigma of another flower on the same plant.



Reasons for occurrence:

- Maturation of the Androecium and Gynoecium at the same time.
- Presence of Anthers at a level equal to Stigmas or slightly higher than them.
- Some flowers remain closed and do not open until pollination is completed.



Means of Pollen Transfer



- Plants rely on external media such as (Wind, Insects, Water, and Humans) to transfer pollen grains. The characteristics of the flower adapt to the method it uses:



1. Cross Pollination by Wind

Flowers pollinated by wind are characterized by features that help them spread and receive pollen easily:

- **Petals:** Small in size and their colors are not bright.
- **Scent:** Odorless and contain no nectar.
- **Anthers:** Long and hanging outwards (to facilitate their opening by wind).
- **Pollen Grains:** Light, dry, and smooth to be easily carried by wind, and produced in very large numbers to compensate for the loss.
- **Stigmas:** Feathery, sticky, and outside the flower to be able to catch pollen grains from the air.



2. Cross Pollination by Insects

These flowers are characterized by features that attract insects (such as bees and butterflies):

- **Petals:** Large in size with bright colors (to attract insects).
- **Scent:** Often scented and secrete nectar to attract insects.
- **Anthers:** Located inside the flower due to the short filament.
- **Pollen Grains:** Sticky or rough to stick to the bodies of visiting insects.
- **Stigmas:** Sticky and located inside to catch pollen grains from the insect's body when it visits the flower.



Note : Light and smooth pollen grains are designed for transport via wind, while sticky or rough pollen grains are designed for transport via insects.



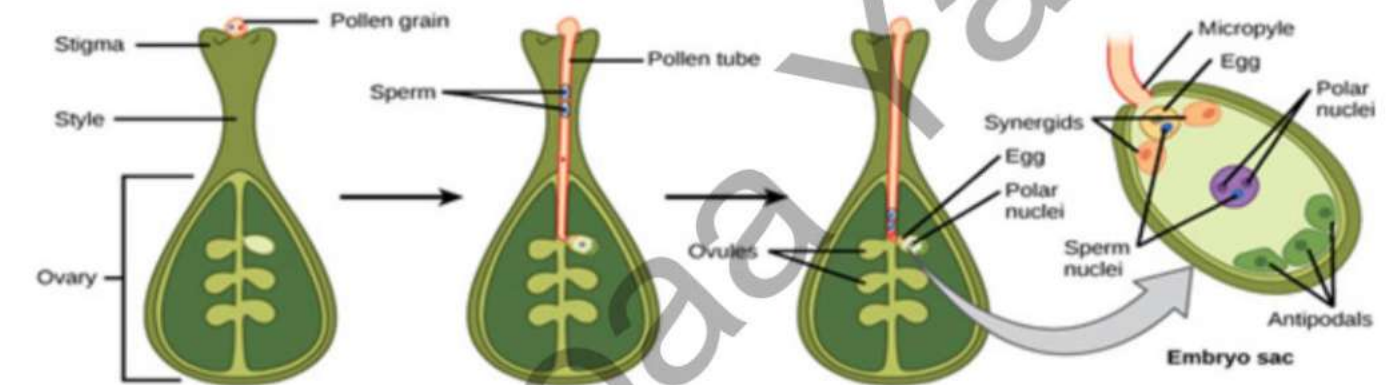
Second: Fertilization and Fruit Formation



The fertilization process begins after pollination, where the pollen grain falls on the stigma of a flower of the same species.

Steps of the Fertilization Process:

1. **Formation of Pollen Tube :** The stigma secretes a sugary solution absorbed by the pollen grain, so it germinates forming a tube called the pollen tube.
2. **Division of Generative Nucleus:** The generative nucleus of the pollen grain divides mitotically to form two male nuclei (n).
3. **Arrival of the Tube:** The pollen tube extends inside the style until it reaches the ovule through the micropyle opening.
4. **Fertilization:** The tip of the pollen tube dissolves, and fertilization occurs by the fusion of one of the two male nuclei with the egg nucleus, forming a fertilized egg (Zygote) which is diploid (2n).
5. **Embryo Formation:** The zygote divides mitotically to form the embryo, which grows to form the seed upon germination.



Fruit Formation

After fertilization, the following changes occur in the parts of the flower:

- **Ovary:** The ovary ripens, transforming into a fruit.
- **Ovules:** The ovules inside the ovary transform into seeds.
- **Floral Whorls:** The calyx, corolla, androecium, stigma, and style usually wither and fall off.

Exceptional cases of remaining whorls:

- The Calyx may remain as in Tomato and Eggplant.
- The Corolla may remain as in Cucumber and Zucchini.
- The Stamens and Sepals may remain as in Pomegranate.



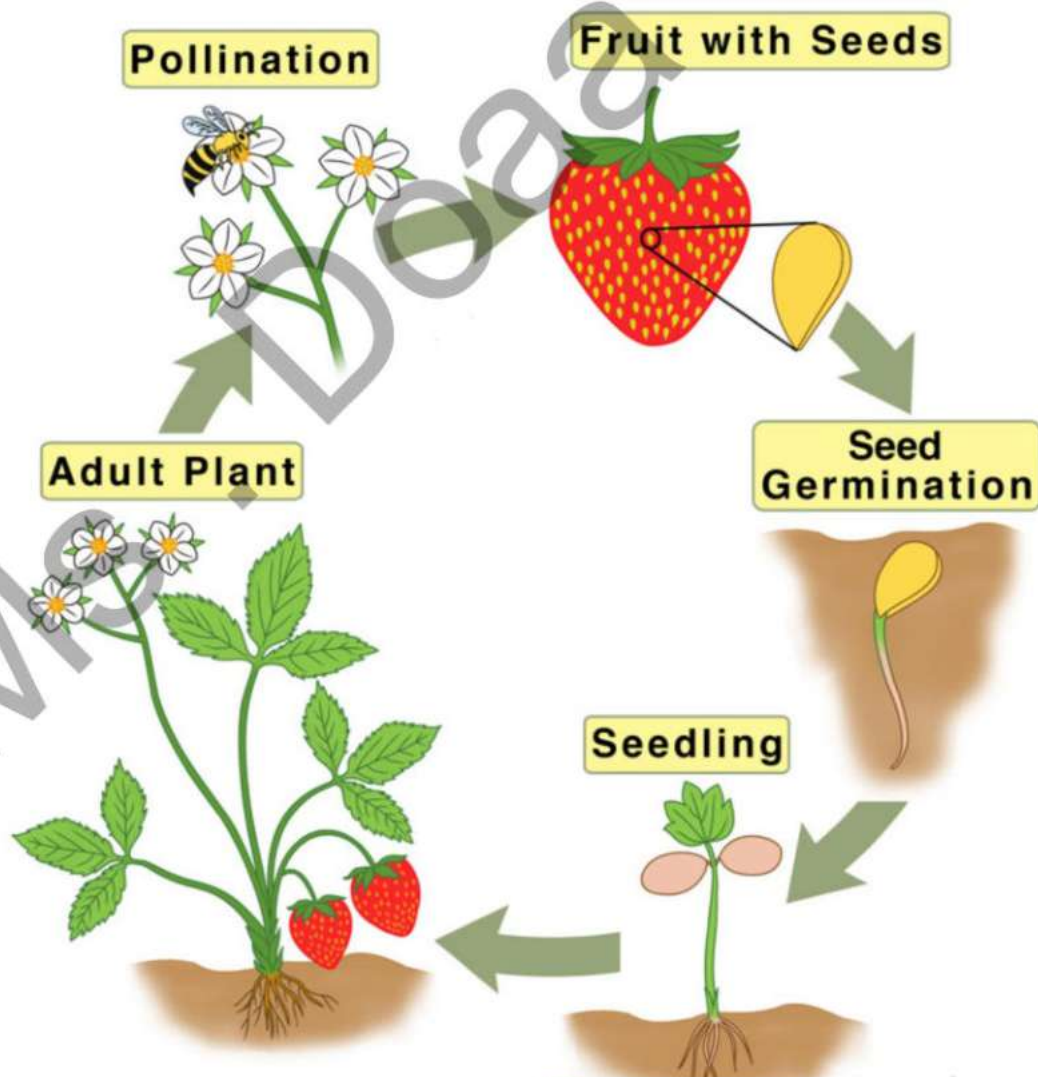
Q: Why does the peach fruit contain one seed, while the pea pod contains many seeds?

A: This is due to the number of ovules inside the ovary. If the ovary contains one ovule (as in Peach), one seed is formed. If it contains many ovules (as in Peas), many seeds are formed.

Life Cycle of Flowering Plants

The life cycle of flowering plants passes through four sequential main stages:

1. **Germination:** The seed transforms into a seedling that begins to emerge from the soil.
2. **Vegetative Growth:** The plant begins to form roots, stems, and leaves, and grows to become a mature plant.
3. **Reproduction:** The mature plant begins to form flowers that reproduce to form fruits containing seeds inside.
4. **Seed Dispersal:** Seeds spread in various ways to fall in a new place, to begin a new life cycle.



Lesson Two: Questions

Multiple Choice Questions

1. The organ responsible for forming female gametes in the flower is:
 (a) Anther (b) Ovary (c) Style (d) Filament
2. The grouping of flowers on the floral axis is called:
 (a) Bract (b) Calyx (c) Inflorescence (d) Receptacle
3. A flower in which the calyx leaves cannot be distinguished from the corolla is known as:
 (a) Flower with Perianth (b) Naked flower (c) Typical flower (d) Unisexual
4. Flowers in Simple Racemose inflorescences open from:
 (a) Top to bottom (b) Inside to outside (c) Bottom to top (d) Outside to inside
5. Which of the following plants has "naked" flowers?
 (a) Narcissus (b) Petunia (c) Tulip (d) Willow
6. The number of floral whorls in a Petunia flower is:
 (a) 2 (b) 3 (c) 4 (d) 1
7. Seeds are formed inside fruits as a result of the transformation of:
 (a) Ovules (b) Ovary (c) Pollen grains (d) Carpels
8. The "Snapdragon" plant is characterized by inflorescences of the type:
 (a) Simple Corymb (b) Simple Raceme (c) Simple Umbel (d) Compound
9. In the municipal Rose flower, the sepals are:
 (a) Fused (b) Colored (c) Absent (d) Separate
10. Which of the following is a condition for self-pollination to occur?
 (a) Maturation of androecium and gynoecium together (b) The flower is unisexual
 (c) Anthers are lower than stigmas (d) Presence of nectar
11. A plant whose petals consist of one fused whorl:
 (a) Municipal Rose (b) Stock (c) Onion (d) Petunia
12. The substance that causes Hay Fever is:
 (a) Nectar (b) Cellulose (c) Pollen grains (d) Chlorophyll
13. The fusion of a male nucleus with the egg nucleus results in a:
 (a) Fruit (b) Seed (c) Zygote (d) Embryo directly

14. Pollen grains transmitted by wind are characterized by being:

- (a) Rough and heavy (b) Dry and light (c) Sticky and large (d) Few in number

15. Cherry plant flowers are an example of inflorescences:

- (a) Corymbose (b) Racemose (c) Umbellate (d) Compound

16. In which of the following plants do the corolla leaves (petals) remain after fruit formation?

- (a) Eggplant (b) Pomegranate (c) Cucumber (d) Tomato

17. Fertilization in flowering plants occurs inside the:

- (a) Stigma (b) Style (c) Anther (d) Ovary

18. The Androecium consists of leaves called:

- (a) Carpels (b) Petals (c) Sepals (d) Stamens

19. Boiled Camomile flowers are used medicinally as a:

- (a) Antihypertensive (b) Painkiller (c) Nerve sedative (d) Antibiotic

20. An example of plants whose fruits contain many seeds:

- (a) Peach (b) Pea (c) Olive (d) Apricot

21. In insect-pollinated flowers, the anthers are:

- (a) Hanging outside (b) Inside the flower (c) Absent (d) Atrophied

22. The Androecium, Stigma, and Style usually wither after:

- (a) Fertilization (b) Pollination (c) Germination (d) Flower opening

Fill in the Blanks

- The flower originates from a vegetative bud that usually emerges from the axil of a leaf called the
- In the Narcissus flower, the outer whorl that combines the calyx and corolla is called the ...
- The male organ in the flower is the while the female organ is the
- After fertilization, the ovule turns into a while the ovary turns into a
- Flowers of wind-pollinated plants are characterized by stigmas to catch pollen.
- The Calyx consists of green leaves called while the Corolla consists of colored leaves called

7. One of the two male nuclei fuses with the egg nucleus to form the which divides to form the
8. Flowers in a Racemose inflorescence open from the to the

Write Scientific Term

1. A short stem whose leaves are modified to form the reproductive organs in the plant.
2. A grouping of flowers emerging on a single floral axis in various arrangements.
3. A green or scale-like leaf from whose axil a flower emerges.
4. The process of pollen transfer from the anther of a flower to the stigma of another flower on a different plant of the same species.
5. The floral whorl consisting of colored leaves with a pleasant scent, functioning to attract insects.
6. Flowers completely devoid of calyx and corolla, such as Willow flowers.
7. The process of the fusion of the male cell nucleus with the egg nucleus to form the zygote.
8. A cell resulting from the fusion of the male nucleus with the egg containing the full number of chromosomes ($2n$).
9. A swelling at the end of the flower pedicel upon which the floral whorls are arranged.
10. A swelling at the end of the stamen filament containing pollen sacs.
11. A small opening in the ovule through which the pollen tube enters to complete fertilization.
12. A flower containing both male and female organs.
13. Inflammation caused by the immune system's response to pollen, leading to sneezing and tearing.

Mark (✓) or (X) with correction

1. A typical flower consists of only three floral whorls.
2. In the Onion plant, the inflorescence takes a shape resembling a tent or umbrella.
3. Pollination is the process of the fusion of the pollen grain with the ovule.
4. Pollen grains in insect-pollinated plants are rough or sticky.
5. The fruit arises from the maturation of the ovule, while the seed arises from the maturation of the ovary.
6. Date palm flowers are unisexual.

7. The calyx remains attached to the fruit in the Eggplant.
8. Hibiscus flowers are used to lower high blood pressure.
9. The pollen grain contains two male nuclei immediately before the pollen tube germinates.
10. Snapdragon flowers are arranged in a simple racemose inflorescence.
11. Self-pollination always occurs in unisexual flowers.
12. The zygote divides meiotically to form the embryo.

Give Reasons (Explain)

1. The petals of insect-pollinated flowers are characterized by bright colors and a pleasant scent.
.....
2. Wind-pollinated flowers produce pollen grains in huge numbers.
.....
3. The stigmas of wind-pollinated flowers are feathery and sticky.
.....
4. Cross-pollination may occur in hermaphrodite (bisexual) flowers despite the presence of both sexual organs.
.....
5. The peach fruit is considered single-seeded, while the pea fruit is many-seeded.
.....
6. "Hay fever" patients are advised to stay away from planted areas in certain seasons.
.....
7. The importance of the presence of a sugary solution on the stigma.
.....
8. The anthers of wind-pollinated flowers hang outside.
.....

What Happens When...

1. A pollen grain falls on the stigma of a flower of the same species.
.....
2. The androecium and gynoecium mature at the same time in a hermaphrodite flower.
.....

3. The ovary contains several ovules after fertilization is complete.

4. The anthers are located at a lower level than the stigmas in a hermaphrodite flower.

5. Stripping a flower of its calyx leaves before it opens.

6. The pollen tube reaches the micropyle.

Comparisons

1. Self-Pollination and Cross-Pollination

2. Simple Racemose Inflorescence and Simple Corymbose Inflorescence

Essay Questions

1. Trace the steps of the fertilization process in a flowering plant from the landing of the pollen grain until the formation of the zygote.

2. Briefly explain the life cycle of flowering plants (The four stages).

3. Mention three medical benefits of flowers, stating the name of the flower and the benefit.

4. What happens to the following floral parts after fertilization: (Calyx - Corolla - Androecium - Ovary - Ovule)?

5. Explain how the flower of a plant pollinated by insects adapts to ensure pollination occurs.

6. Classify simple inflorescences according to the shape of the axis and the arrangement of flowers.

7. Mention one exceptional case for each of: (Persistence of Calyx - Persistence of Stamens).

.....

8. What is the relationship between the "Micropyle" and seed formation?

.....

Ms. Doaa Yasser

unit 4

Physical changes in the atmosphere

- **Lesson One: The effect of temperature and pressure on climate formation**
- **Lesson Two: Winds and weather forecasts**

1

The Effect of Heat and Pressure on the Formation of Climate

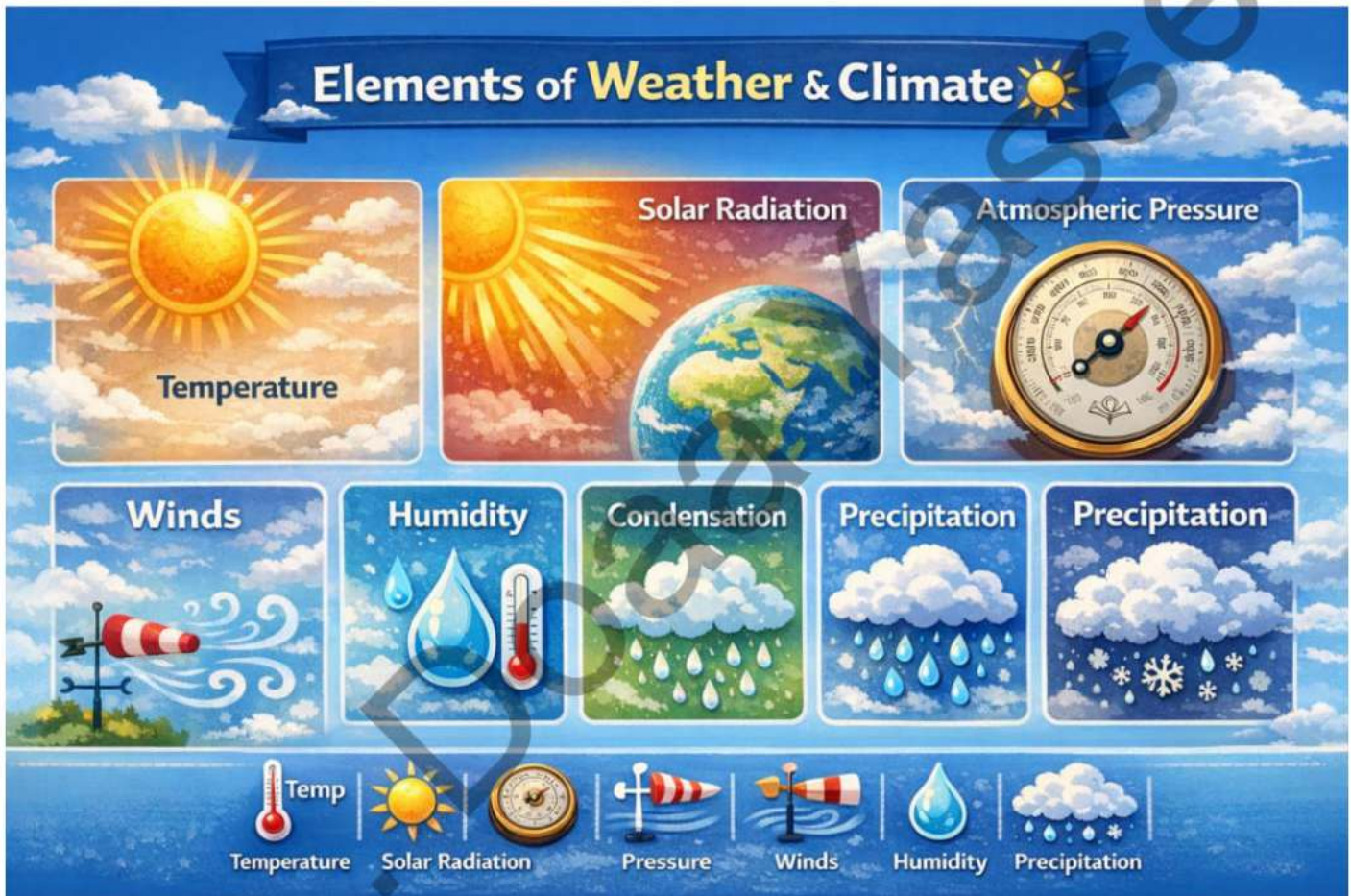
Weather:

It is a description of the state of the atmosphere in a specific place during a short period of time (hour, day, week) and it is constantly changing.

Climate:

It is the state of the atmosphere or the prevailing condition in a specific place during a long period of time (months, years, decades).

Elements of Weather & Climate



First: Temperature:

Temperature is considered the most important climatic element due to its direct effect on human life and the distribution of plants and animals on the surface of the Earth.

Factors Affecting Temperature

1. Difference in Latitudes

- Whenever we get closer to the Equator (latitude 0°), the temperature increases. And whenever we head north or south towards the Poles (90° North or South), the temperature decreases.

- **At the Equator:** The sun's rays fall perpendicularly or semi-perpendicularly; this means that the same amount of solar energy concentrates on a small area, leading to intense heating.
- **At the Poles:** The sun's rays fall very obliquely. This makes the same amount of energy distribute over a very wide area, and the result is much less heating.

2. Proximity to Water Bodies

- Coastal areas (close to seas and oceans) enjoy a milder atmosphere than interior areas (desert [ones]).
- The reason is the high specific heat of water compared to land, as it makes water bodies colder than the land adjacent to them by day, causing sea breeze, and warmer by night, causing land breeze.

Sea Breeze:

oThe land heats up faster than the sea water. The hot air over the land rises upwards (because it is less dense), so cold air coming from over the sea surface takes its place.

SEA BREEZE & LAND BREEZE



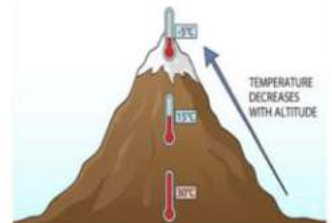
Land Breeze:

oThe land loses its heat faster than the water, so it becomes colder than the sea water. Where the warm air rises from over the sea surface, and colder air coming from the land takes its place.



3. Altitude Above Sea Level

- Whenever we rise upwards above sea level, the temperature decreases.



The Reason:

Air Expansion:

When air rises upwards, the atmospheric pressure upon it decreases, so it expands. This expansion process consumes energy, leading to a decrease in the air temperature.

Decrease in Density:

At high altitudes, the air is less dense, and its molecules (air particles) are distant from each other. This makes its ability to retain heat less.

- **Example: We find snow on mountain peaks even if they are located in hot regions.**

Calculations Related to Temperature

Used in meteorology.



Maximum Temperature

The highest temperature recorded in a single day (usually in the afternoon period).





Minimum Temperature

The lowest temperature recorded in a single day (usually before sunrise).





Daily Average Temperature

(Maximum Temperature + Minimum Temperature) ÷ 2

It is the average of the maximum temperature and the minimum temperature.



Daily Thermal Range (Diurnal Range)

It is the difference between the maximum temperature and the minimum temperature.

Thermal Range =
Max. Temp. - Min. Temp.




Second: Atmospheric Pressure

Practical Activity (1): The Balloons Experiment

Scientific Goal: Proving that air has weight.

Materials: Two identical balloons having the same volume / a rod / a pin.

Steps:

1. Fixing the rod in a horizontal position.
2. Hanging the two balloons to form a balanced lever of the first type.
3. Puncturing one of the balloons with a sharp pin.

Observation:

- As soon as the air exited, an imbalance of the lever occurred; the end carrying the inflated (intact) balloon drops downwards, while the end carrying the punctured (empty) balloon rises.

Conclusion:

- The end that dropped downwards is the "heavier" one. This means that the balloon filled with air is heavier than the empty balloon. The only difference between them is the presence of air. Therefore, air has weight.



Practical Activity (2): The Egg and Bottle Experiment

Scientific Goal:

Proving the existence of pressure for atmospheric air.

Materials:

A peeled boiled egg / a bottle / a piece of paper / a matchstick.

Steps:

1. A peeled boiled egg is placed on the mouth of a bottle. The egg does not fall inside because its size is slightly larger than the mouth.
2. The egg is lifted temporarily, and a small piece of paper is lit and thrown inside the bottle.
3. The egg is placed again quickly on the mouth before the flame goes out.

Observation:

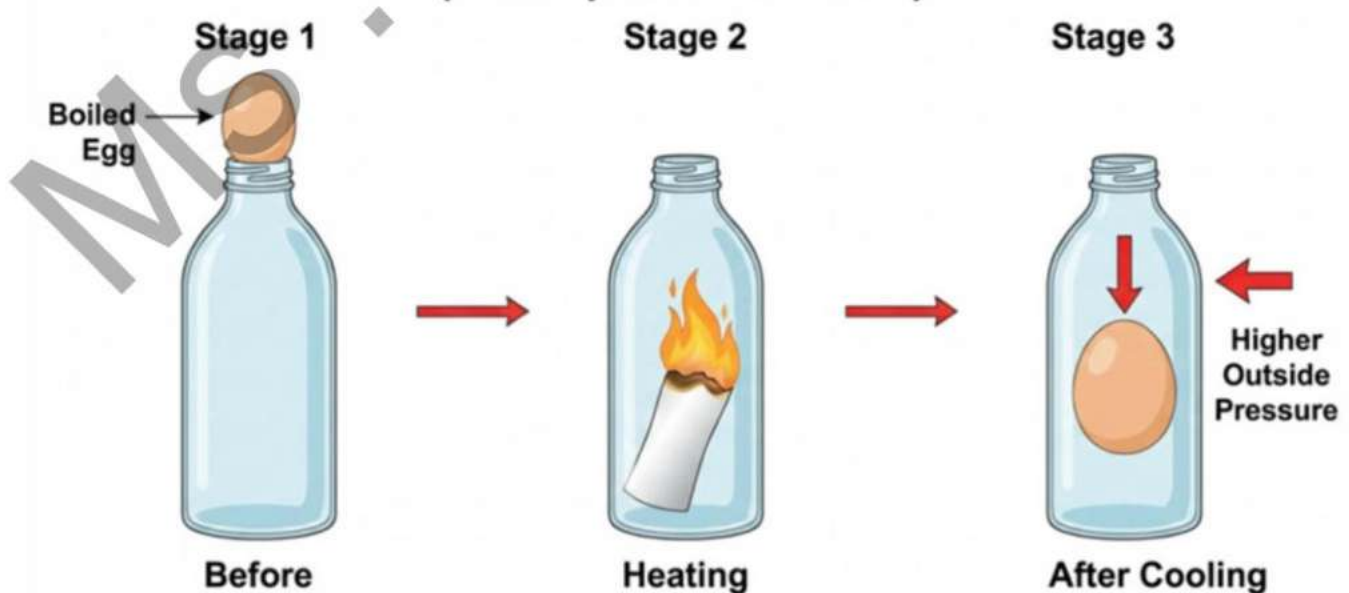
- After the flame goes out, the egg is pulled forcefully inside the bottle and falls into it.

Conclusion:

1. The Natural State: Air pressure outside the bottle and inside it is equal, therefore the egg does not move.
2. Upon burning the paper: The air inside the bottle heats up, so it expands and part of it exits.
3. After the flame extinguishes: The remaining air inside the bottle cools quickly, so it shrinks and its pressure decreases significantly.
4. The Result: The air pressure outside the bottle (atmospheric pressure) becomes much higher than the low pressure inside it. This large difference in pressure generates a force pushing the egg from the outside to the inside.

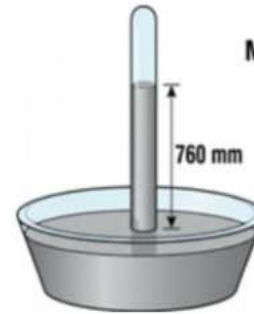
This proves that air has pressure, and that this pressure is strong enough to push objects

EGG AND BOTTLE EXPERIMENT (Atmospheric Pressure)



Atmospheric Pressure:

It is the weight of a column of air whose cross-sectional area is 1 m^2 and whose length is the height of the atmosphere and is measured via the mercury barometer device.



MERCURY BAROMETER

Standard Atmospheric Pressure at Sea Level
 $= 760 \text{ mm Hg}$
 $= 1013.25 \text{ mb}$

Standard Atmospheric Pressure:

It is the atmospheric pressure at sea level and it equals the weight of a column of mercury whose length is **76 cm (760 mm.Hg)** acting upon a unit area, and it is equivalent to **1013.25 millibars**.

Mathematical Understanding:

Every **1 millibar (mb)** equals **0.75 mm** of mercury (mm.Hg).

$$\text{Pressure (mb)} = \text{Pressure (mm.Hg)} / 0.75$$



$$1 \text{ millibar} = 0.75 \text{ mm of mercury}$$

$$\text{Pressure (mb)} = \text{Pressure (mm.Hg)} / 0.75$$



Applied Example :

If the standard atmospheric pressure is **760 mm.Hg**, then how much does it equal in millibars?

$$\text{Pressure (millibar)} = 760 \text{ mm.Hg} / 0.75 \approx 1013.3 \text{ millibars.}$$

Factors Affecting Atmospheric Pressure

ALTITUDE	TEMPERATURE	HUMIDITY
Higher Altitude → Lower Pressure	Higher Temp → Lower Pressure	Higher Humidity → Lower Pressure

1. Altitude Above Sea Level

- Whenever we rise above sea level, the weight of the length of the atmospheric air column acting upon a unit area decreases, and consequently atmospheric pressure decreases.

2. Temperature

- Upon the rise of the Earth's surface temperature, the air close to it expands, leading to a decrease in its density, and consequently a decrease in atmospheric pressure, and vice versa.

3. Humidity

- Humidity is the quantity of water vapor present in the air.
- The percentage of humidity differs from one place to another and from one timing to another.

Absolute Humidity:

The actual mass of water vapor present in a specific volume of atmospheric air and is estimated in the unit (g/m³)

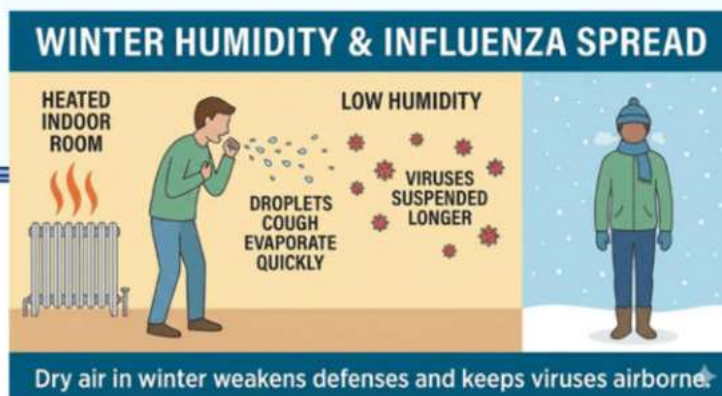
Relative Humidity:

It is the percentage ratio between the mass of water vapor actually present in a specific volume of air (absolute humidity) and the maximum mass of water vapor that the same volume of air can hold at the same temperature (maximum capacity)

Atmospheric pressure decreases slightly upon the increase of humidity, because the density of water vapor is less than the density of dry air.

Integration with Biology :

The spread of influenza increases in the winter season, because cold air has low humidity. And upon heating the air inside buildings with the stability of absolute humidity, relative humidity drops sharply, which works on evaporating droplets rapidly, which increases the remaining of viruses suspended in the air for a longer period of time, and also the evaporation of water from mucous membranes lining the nose and the respiratory system, which weakens their ability to resist viruses



Lesson One: Questions

Choose the correct answer:

1. Description of the state of the atmosphere in a specific place during a short period is known as:
 (a) Climate (b) Weather (c) Atmospheric Pressure (d) Humidity
2. The animal that lives in hot regions is:
 (a) Polar Bear (b) Fox (c) Penguin (d) Egyptian Lynx
3. Sun rays fall at the poles (90° North and South) in a form that is:
 (a) Perpendicular (b) Semi-perpendicular (c) Very oblique (d) Non-existent
4. The air touching the land at night in the land breeze phenomenon is:
 (a) Hot and rises (b) Cold and high density (c) Very humid (d) Low pressure
5. The device used to measure atmospheric pressure is:
 (a) Mercury Barometer (b) Anemometer (c) Thermometer (d) Hygrometer
6. The standard atmospheric pressure at sea level equals mm Hg.
 (a) 76 (b) 760 (c) 1013 (d) 1000
7. The relationship between air temperature and its density is a relationship that is:
 (a) Direct (b) Constant (c) Inverse (d) Irregular
8. Moist air has an atmospheric pressure that is compared to dry air.
 (a) Higher (b) Lower (c) Equal (d) Double
9. The spread of influenza increases in winter due to the decrease in:
 (a) Atmospheric Pressure (b) Wind Speed (c) Humidity (d) Specific Heat
10. Sun rays fall perpendicular, so energy is concentrated in a small area at:
 (a) The Poles (b) Europe (c) Tropic of Cancer only (d) The Equator
11. The lowest temperature recorded in the day is usually:
 (a) At noon (b) Immediately after sunset (c) Midnight (d) Before sunrise
12. The standard atmospheric pressure is estimated at millibars.
 (a) 1000 (b) 1013.25 (c) 760 (d) 76

13. The ability of air to retain heat decreases at high altitudes due to:

- | | |
|-----------------------------------|--------------------------------|
| (a) Spacing of air molecules | (b) Closeness of air molecules |
| (c) Increase in oxygen percentage | (d) Decrease in wind |

14. At the equator, sun rays are distributed over a area, causing intense heating.

- | | | | |
|----------|-----------|------------|---------------|
| (a) Wide | (b) Small | (c) Medium | (d) Unlimited |
|----------|-----------|------------|---------------|

Complete the following:

- Climate is the prevailing state of the atmosphere in a specific place during a period of time, while Weather is for a period.
- Standard atmospheric pressure equals the weight of a column of mercury with a length of cm.
- Atmospheric pressure decreases with the increase of humidity because the density of is less than the density of
- In polar regions, sun rays fall so the energy is distributed over a area.

Write the Scientific Term:

- Description of the state of the atmosphere in a specific place during a short period of time.
- The prevailing state of the atmosphere in a specific place during a long period of time.
- A phenomenon occurring during the day where cold air moves from the sea to replace the hot air over the land.
- A phenomenon occurring at night where cold air moves from the land to replace the warm air over the sea.
- The weight of a column of air with a cross-sectional area of 1 m^2 and a length equal to the height of the atmosphere.
- The actual mass of water vapor present in a specific volume of atmospheric air.
- The percentage ratio between the actual mass of water vapor and the maximum mass the air can hold at the same temperature.
- The difference between the maximum temperature and the minimum temperature in a single day.
- The highest temperature recorded in a single day.
- The climatic zone located between latitudes 66.5 and 90 North and South.
- The atmospheric pressure at sea level, equivalent to 1013.25 millibars.

True or False (Correct the error):

1. Weather is the description of the state of the atmosphere for a long period of time that may reach years.
2. The closer we get to the poles, the temperature increases due to the perpendicularity of the sun.
3. The specific heat of water is higher than land, which causes the phenomena of land and sea breezes.
4. Cold air is denser than hot air
5. Atmospheric pressure increases the higher we rise above sea level.
6. Moist air has a higher atmospheric pressure than dry air
7. Land breeze occurs during the day when the land heats up faster than the water
8. The mercury barometer is used to measure temperature
9. The spacing of air molecules at high altitudes reduces its ability to retain heat
10. The relationship between temperature and atmospheric pressure is a direct relationship.
11. The daily average temperature is the result of subtracting the minimum temperature from the maximum
12. Low humidity in winter causes dryness of mucous membranes and increases influenza infection

Give Reasons For:

1. Decrease in temperature the higher we rise above sea level.

.....

2. Occurrence of sea breeze during the day.

.....

3. Moist air has lower atmospheric pressure than dry air.

.....

4. Temperature varies at the equator compared to the poles.

.....

5. Influenza spreads more widely in the winter season.

.....

6. Atmospheric pressure decreases as we go upwards.

.....

7. Coastal areas enjoy a milder weather than inland desert areas.

8. Decrease in air density when its temperature rises.

What happens if:

1. Sun rays fall very obliquely on the poles.

2. Hot air rises over the land during the day in coastal areas.

3. Increase in altitude above sea level regarding temperature.

4. Lighting a paper inside a bottle closed with an egg, then the flame goes out.

5. Increase in the percentage of air humidity (water vapor) in a certain area regarding atmospheric pressure.

6. Heating a specific area of the earth's surface regarding the air touching it.

Compare between:

1. Weather and Climate.

2. Sea Breeze and Land Breeze.

General Questions

1. If the maximum temperature in a city is 35°C and the minimum is 25°C . Calculate the daily average temperature and the thermal range.

1. If the atmospheric pressure in an area is 760 mm Hg. Calculate its value in millibars.

2. What are the factors affecting temperature?

- 3. Explain how humidity affects the health of the human respiratory system in winter.
.....
- 4. Explain the mechanism of the occurrence of "Land Breeze".
.....
- 5. What is the relationship between "air expansion" and its cooling when rising upwards?
.....
- 6. How does proximity to water bodies affect the daily thermal range?
.....

Ms. Doaa Yasser

2

Wind and Weather Forecasts

Wind

It is the horizontal movement of air on the Earth's surface, which arises due to the difference in atmospheric pressure from one region to another as a result of the uneven heating of the Earth's surface

Discuss this lecture

The concept of winds, the causes of their emergence, and their relationship to atmospheric pressure ranges and the Coriolis effect. It also explains atmospheric pressure systems, weather maps, and weather forecasting methods, and their importance in protecting humans and supporting various activities.

Atmospheric Pressure Zones

High Atmospheric Pressure (H):

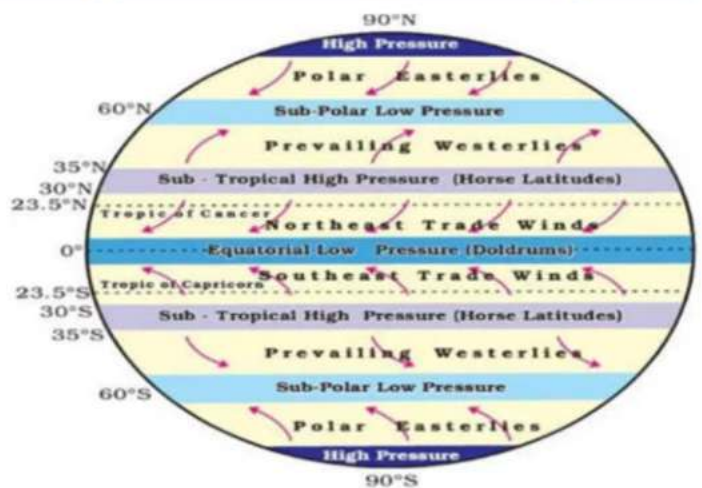
Forms in the polar regions as a result of the drop of both temperature and humidity percentage

Low Atmospheric Pressure (L):

Forms in the equatorial region as a result of the rise of both temperature and humidity percentage.

Atmospheric Pressure Zone	Approximate Location	The Cause	Symbol
Equatorial Low Pressure	Equator (0°)	Rise in temperature and humidity	L
High Pressure	Latitude 30°N and 30°S		H
Low Pressure	Latitude 60°N and 60°S		L
Polar High Pressure	Latitude 90°N and 90°S	Drop in temperature and humidity	H

- Air always moves from regions of High atmospheric pressure (H) to regions of Low atmospheric pressure (L).
- Wind movement and speed increase whenever the difference is large between atmospheric pressure values in adjacent regions.



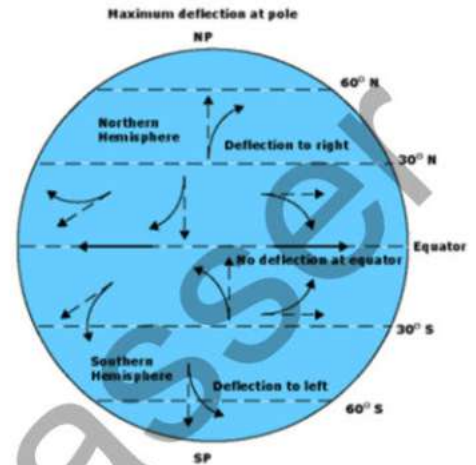
Major Pressure Belts and Wind System

Coriolis Effect

- This effect results from the Earth's rotation around its axis from west to east. As a result of this rotation, winds do not move in straight paths (except at the equator), but rather deflect into curved paths.

Deflection Rules

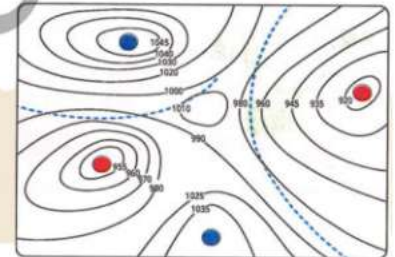
- Northern Hemisphere** : Winds deflect to the right of their original direction (with the direction of clockwise rotation).
- Southern Hemisphere** : Winds deflect to the left of their original direction (against the direction of clockwise rotation).
- And wind deflection** is maximum at the poles.



Weather Maps



- Weather maps illustrate the movement of air masses based on wind speed and atmospheric pressure systems.



Atmospheric Pressure Systems

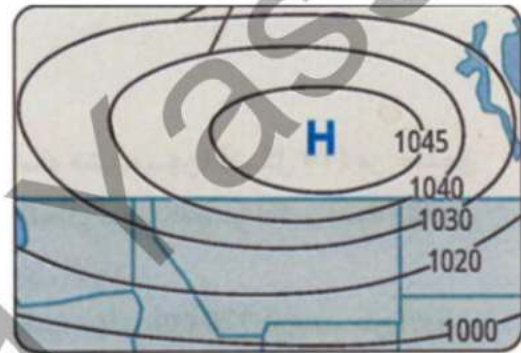
- Divided into atmospheric depressions (lows) and atmospheric highs.

Isobars:

They are points of equal atmospheric pressure at sea level, and are represented on weather maps by curved lines.

Aspect	Low-Pressure System (L)	High-Pressure System (H)
Definition	A region where the pressure at the center is lower than in the surrounding areas.	A region where the pressure at the center is higher than in the surrounding areas.
Symbol on Weather Maps	Represented by the letter L (usually red).	Represented by the letter H (usually blue).
Air Movement (Vertical)	Ascending air currents rise upward.	Descending air currents move downward.

Effect on Air	Rising air cools and condenses.	Descending air warms and dries.
Clouds and Rain	Leads to cloud formation and rainfall .	Leads to clear and sunny weather .
Horizontal Air Movement (Northern Hemisphere)	Air moves towards the center in a counter-clockwise direction.	Air moves away from the center in a clockwise direction.
Weather Condition	Unstable weather (cloudy, rainy).	Stable weather (clear, sunny).



Weather Bulletin Symbols:

The weather bulletin maps include icons (symbols) from which the state of the weather is inferred, and they are



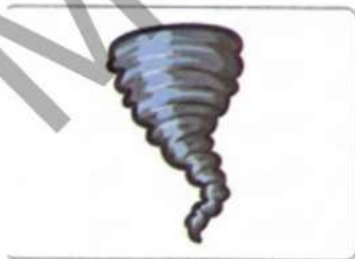
Rainfall



Cloudy



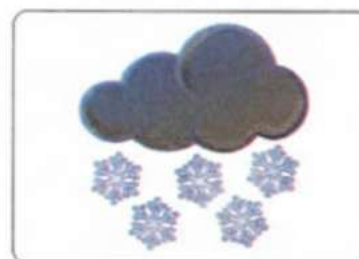
Sunny Weather



Tornadoes



Thunder and Lightning



Snowfall

Weather Forecasts

- It is the expectation of the future state of the atmosphere in a certain place. This is done by collecting, recording, and analyzing probable data about temperature, wind speed, atmospheric pressure, and storm paths using technologies, such as:

1. Meteorological Booth (Stevenson Screen) X

- Structure:** It is a box 65 cm long made of wood, painted in glossy white color to reflect sunlight instead of absorbing it.
- Ventilation:** The box contains slanted vents that allow air to enter and exit freely.
- Height and Location:** The box is installed on a stand that raises it about 120 centimeters (1.2 meters) above the ground. This height is important to protect the measuring instruments inside it from the heat radiated by the Earth. It is also placed in an open area, away from trees and buildings, because these obstacles can affect the measurements.
- Internal Instruments:** The booth contains a set of precise instruments to measure temperature, humidity, and atmospheric pressure.



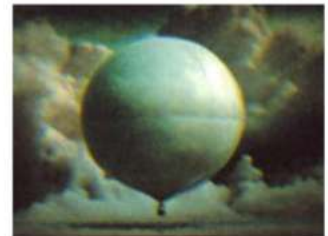
2. Weather Buoys: X

- Used in oceans, which collect data received from sensors to organize and process it, then send this data via satellites to monitoring centers around the world.



3. Radiosonde (Radio Probe) X

- Earth's surface data alone is not enough, as most weather phenomena form in the upper layers of the atmosphere. Here comes the role of the radiosonde.



- Structure:** It is a box carrying measuring instruments (temperature, pressure, humidity, and wind speed) carried by a large balloon filled with helium or hydrogen gas. These gases are lighter than air, which makes the balloon rise upwards.
- Timing:** It is launched twice daily from hundreds of stations around the world at two specifically determined global times (noon time and midnight).
- Process:** During the balloon's ascent, the instruments measure the surrounding conditions and continuously send data via radio waves to ground stations.
- The End:** The balloon continues to rise until it reaches a towering height (between 20 and 35 kilometers), where atmospheric pressure is very low. The pressure difference between inside the balloon and outside it leads to the balloon's expansion until it explodes. After that, the instrument box descends slowly to the ground using a small parachute. Mostly, it is not reused again due to the difficulty of retrieving it or its exposure to damage.



4. Satellites: X

Orbit around the Earth.



Q5. Weather Stations: X

- Distributed in every country of the world in different regions to collect weather data continuously and regularly.



Q: Are weather forecasts absolute facts?

A: No. Forecasts are "probable expectations" and not confirmed facts. The reason is that the atmosphere is affected by a large number of interacting variables. Therefore, the more we try to predict for a longer period of time in the future, the rate of uncertainty increases and small errors accumulate. For this reason, "forecasting for a coming week is less accurate than forecasting for two coming days."



Importance of Weather Forecasts

1. **Protecting Lives and Property:** When predicting dangerous weather phenomena such as hurricanes, floods, thunderstorms, or severe heat and cold waves, early warnings can be issued, allowing people to take necessary preventive measures such as evacuation or securing property.
2. **Supporting Economic Activities:** As in helping farmers determine times for planting, irrigation, harvesting crops, and pest control, which increases productivity and reduces losses.
3. **Aviation and Navigation Safety:** Accurate forecasts of winds and storms help in avoiding weather conditions that might threaten air navigation movement.



Preventive Awareness

- Following up on weather bulletins is observed to take appropriate precautions when weather fluctuations occur, such as wearing appropriate clothes, avoiding crowded places, and making the appropriate decision regarding traveling by land or sea.
- In the spring season of every year, Egypt witnesses weather fluctuations that can lead to the formation of storms loaded with sand and dust, known as Khamasin winds, which negatively affect the health of the respiratory system.

Lesson Two: Questions

Choose the correct answer:

1. Winds arise primarily as a result of the difference in from one region to another.
(a) Humidity percentage (b) Atmospheric Pressure (c) Earth's rotation (d) Terrain
2. The main factor responsible for the difference in atmospheric pressure on the Earth's surface is:
(a) Uneven heating (b) Wind speed (c) Earth's rotation (d) Vegetation cover
3. Low atmospheric pressure (L) forms in tropical regions due to:
(a) Low heat and humidity (b) High heat and low humidity
(c) High heat and humidity (d) Low heat and high humidity
4. At latitude 30° North and South, a pressure belt is formed that is
(a) Tropical Low (b) Neutral (c) Polar Low (d) High
5. The Coriolis effect leads to the deflection of winds their direction in the Northern Hemisphere.
(a) Right (b) Left (c) Opposite (d) Perpendicular to
6. The deflection of winds resulting from the Earth's rotation is at its maximum at
(a) The Equator (b) The Tropics (c) The Poles (d) The Oceans
7. Winds rotate around the center of a High Pressure (H) system in the Northern Hemisphere:
(a) Clockwise (b) Counter-clockwise (c) In straight lines (d) Towards the center
8. The weather in High Pressure (H) areas is characterized as being:
(a) Cloudy and rainy (b) Stormy and thundery (c) Clear and sunny (d) Very humid
9. The meteorological screen (Stevenson screen) is raised above the ground by:
(a) 65 cm (b) 2 meters (c) 120 cm (d) 35 km
10. The Radiosonde balloon bursts when reaching high altitudes due to:
(a) High temperature (b) Strong winds
(c) Colliding with clouds (d) Decrease in atmospheric pressure

11. The gas used to fill the Radiosonde balloon is:

- (a) Oxygen (b) Helium (c) Nitrogen (d) Carbon Dioxide

12. The accuracy of weather forecasts for a period of a week is its accuracy for a period of two days.

- (a) Higher than (b) Less than (c) Equal to (d) Double

13. The Radiosonde is used to transmit data via waves.

- (a) Sound (b) Light (c) Radio (d) Infrared

14. Weather data is collected from oceans using:

- (a) Stevenson screen (b) Radiosonde (c) Ground stations (d) Weather buoys

15. The direction of wind rotation around a Low Pressure system in the Northern Hemisphere is:

- (a) Clockwise (b) Counter-clockwise (c) Perpendicular (d) Away from the center

16. The Radiosonde is launched globally:

- (a) Every hour (b) Once daily (c) Twice daily (d) Weekly

17. The symbol for High Pressure on maps is:

- (a) L (b) H (c) M (d) P

Complete the following:

1. In the Northern Hemisphere, winds deflect the direction of clock movement, while in a Low Pressure system, winds rotate the clock.
2. Low Pressure is symbolized by the letter and usually in the color
3. The Radiosonde consists of a box carrying measuring instruments and a balloon filled with or gas.
4. The Stevenson screen is raised about meters above the ground to protect the devices from
5. The Radiosonde is launched at two specific times globally, which are and
6. In Low Pressure areas, air currents form, causing
7. Areas located at latitude 60° North and South are characterized by atmospheric pressure, while areas at latitude 30° are characterized by pressure.

Write the Scientific Term:

1. The horizontal movement of air on the Earth's surface as a result of atmospheric pressure difference.
2. The deflection of winds from their straight path as a result of the Earth's rotation around its axis.
3. Curved lines connecting points of equal pressure on weather maps.
4. An area where the pressure value at its center is lower than the surrounding areas.
5. An area where the pressure value at its center is higher than the surrounding areas.
6. A white wooden box with slanted slats used to protect meteorological instruments.
7. A device carried by a balloon to measure weather elements in the upper layers of the atmosphere.
8. Winds loaded with dust and sand that blow over Egypt in the spring season and harm the respiratory system.
9. Predicting the future state of the weather in a place based on data collection and analysis.
10. Floating devices used in oceans to collect weather data and send it via satellites.

True or False (Correct the error):

1. Winds move from low pressure areas to high pressure areas
2. Winds deflect to the left of their direction in the Southern Hemisphere
3. High Pressure is characterized by the presence of rising air currents and rainfall
4. Isobars are straight lines connecting points of equal pressure
5. The Stevenson screen is painted black to absorb heat
6. The Radiosonde balloon bursts at an altitude of 20-35 km due to the increase of atmospheric pressure inside it over the outside.
7. Weather forecasts help farmers in determining planting and irrigation schedules
8. The Stevenson screen is placed under trees for protection from rain

Give Reasons For:

1. Deflection of winds from their straight path on the Earth's surface.
-

2. Painting the Stevenson screen in glossy white.
-

3. Presence of slanted slats in the Stevenson screen.

4. Raising the Stevenson screen about 1.2 meters from the ground.

5. Explosion of the Radiosonde balloon when reaching high altitudes.

6. Formation of a low-pressure area at the equator.

7. Low pressure is usually accompanied by rainfall and clouds.

8. Weather forecasts for a week are less accurate than forecasting for two days.

9. High pressure is characterized by clear and dry weather.

What happens if:

1. There is a large difference in atmospheric pressure between two adjacent regions.

2. Ascent of air currents in the center of a Low Pressure system.

3. Arrival of the Radiosonde balloon to an altitude of 30 km.

4. Descent of air currents in a High Pressure area.

5. Placing the Stevenson screen adjacent to a building or a tree.

6. Occurrence of weather fluctuations and Khamasin winds in Egypt.

General Questions:

1. Explain the mechanism of the Radiosonde's operation from the moment of its launch until the return of the devices to Earth.

.....

2. What is the importance of weather forecasts for economic activities?

.....

3. What is the relationship between Humidity and Atmospheric Pressure?

.....

4. What role do "Weather Buoys" play?

.....

5. What are Khamasin winds and what is their effect?

.....

6. How is atmospheric pressure represented on weather maps?

.....

7. Mention three devices usually found inside the Radiosonde.

.....